GOAT HUSBANDRY

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by

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AUTHOR'S PREFACE

Nearly twenty years ago, I retired into a converted hen house with a milking pail, a book of instructions, and an elderly goat of strong character. There was milk, among other things, in the pail when the goat and I emerged at last, with mutual respect planted in both our hearts. The book of instructions was an irrecoverable casualty.

No book is a substitute for practical experience; but books become more important as animals become more productive; the modern farmer and small-holder has to remember so much, so often and so quickly that each class of farm livestock requires to be accompanied by a comprehensive work of reference as a passport to the modern farmyard.

Holmes Pegler's *The Book of the Goat* was published first in 1875, and is at present in its ninth edition; *Modern Milk Goats*, by Irmagarde Richards, was published during the first quarter of the present century in the U.S.A. In the meantime there have been published on both sides of the Atlantic a number of excellent practical handbooks on goat-keeping, goat-farming and goat fancying, but no work with so wide a scope as *The Book of the Goat*. The omission is one of several handicaps to an expansion of commercial goat-keeping and always struck me as surprising until I found myself involved in the attempt to fill it.

The fact is that the study of the goat has commanded rather less scientific attention than the study of mice and guinea-pigs. The practice of goat-keeping in Britain, though successful in establishing world milk production records and a vigorous export trade, is so highly variable, individual and empirical that it is almost indescribable. In search of information from scientific and technical institutions, the writer on goats is liable to be treated with the respect accorded to all things pertaining to the goat in Britain. While the majority of the leading exponents of goat-keeping practice in this

country are eager to help, few have the time or temperament to measure and record their own practice with useful accuracy.

At several stages in the writing of this book I should have quailed before the obstacles so presented, but for the encouragement of Lawrence D. Hills and his fertile suggestions.

To Professor S. A. Asdell of Cornell University, U.S.A., and to Professor C. W. Turner of Columbia University, U.S.A. I am particularly grateful, not only for guiding me to the scientific work which laid the basis of the study of goat nutrition, but for their kindness to a stranger.

Many of my readers may agree with me in regarding the section dealing with problems of mineral imbalance in the goat as of greater practical use to the breeder than any other in this book; they will wish to join me in thanking Dr. E. C. Owen of the Hannah Dairy Research Institute, and Brynmor Thomas of the Durham University School of Agriculture, who have provided me with much of the material on which this section is founded.

In my chapter on 'Goats' Milk in Human Nutrition', as a stockman and farmer, I found myself on rather unfamiliar ground; I am particularly grateful to Dr. J. B. Tracey for reading my chapter and enabling me to enrich it with the fruits of his unique joint experience of goats and medical practice. For guidance in the special literature on this subject, I am indebted to Dr. Mavis Gunther, M.A., M.D., of University College Hospital, London, whose kindness in reading and criticizing the chapter has greatly strengthened it. I was also assisted here by the advice of Sister E. Morrison, of *Nursery World*, based on her incomparable experience of the feeding troubles of 'difficult' infants, and by the classic work and personal assistance of F. Knowles, Honorary Analyst to the British Goat Society.

I would also express my thanks to many busy men of science who found time to give me help on technical points; to Stephen Williams, M.Sc., farms manager to Boots Pure Drug Company, for sources of information on the food capacity of the cow; to the Veterinary Advisory Department of Boots Pure Drug Company for information on the relationship between parasitic worm infestations and Vitamin B deficiencies; to James A. Paterson of the Scottish Milk Records Association; to Dr. Fraser Darling; to C. A. Cameron, managing director of Alginate Industries (Scotland); to G. Kenneth Whitehead, Withnell Fold; to the Mond Nickel Company for information on cobalt, and to the Iodine Educational Bureau for a good deal of material on breeding troubles.

The short survey of industrial waste products suitable for goat-feeding obliged me to trespass on the kindness of the technical executives of a number of firms; I thank Dr. V. L. S. Charley of H. W. Carter & Company for a particularly happy correspondence on the use of black currant pomace, and for generous assistance in investigating the matter; R. B. Norman of H. J. Heinz Company, W. E. Rhodes of Chivers & Sons, R. S. Potter of William Evans & Company, and R. E. Harris of Calindus Food Products for their helpful information.

I have particularly enjoyed the correspondence with friends of the goat in other countries, and hope that the list of names and addresses in Appendix 1 will not only aid the circulation of knowledge on goat-keeping but enable travelling goat-keepers to make contacts over a considerable proportion of the world. In compiling this list and for information on world goat-keeping I am indebted to Tanio Saito of Uwajima, Japan, S. de Jogn Szn., Secretary of the Goat Society of the Netherlands, Sigurd Andersen, Editor of the *Journal* of the Danish Goat Society, Mr. Robert W. Soens, Secretary of the American Milk Goat Record Association, Monsieur C. Thibault, Director of the Station for Research in Animal Physiology, Jouy-en-Josas, France, and Mrs. du Preez of Cape Province, South Africa and Dr. Finci of the Department of Agriculture of Israel.

Of goat-keepers in this country I must first express my gratitude to Miss M. F. Rigg, the ever-helpful Secretary of the British Goat Society, whose assistance has been spread over the several years during which the book was being prepared, and has been indispensable. I acknowledge with gratitude the permission of the Committee of the British Goat Society to make use of photographs and many extracts from articles first published in the British Goat Society year books and monthly journals. I thank the many contributors to these richest sources of goat knowledge.

Of individual goat-breeders I owe a special debt to Mrs. J. Oldacre, Hanchurch Yews, for the photographs of yarded goats, the plans of a model goat-yarding system and goat garden prepared by her architect husband, and for some of the most carefully recorded information on practical goat-keeping that it has been my pleasure to use; to J. R. Egerton for many beautiful photographs and for information on RM5 Malpas Melba; to the Lady Redesdale for her cheese recipe; to Mrs. Jean Laing, Moorhead, Newton Stewart, for photographs, for information on her feeding methods and for providing a shining example of economic methods of management; to Miss Mostyn

Owen, Mrs. Margaret Train and Mrs. J. D. Laird for photographs; and to Miss Jill Salmon, Cothlan Barn, for some fine photographs and for that rare and precious material—accurately recorded information on feeding for high yields.

I am grateful to the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland for the trouble they have taken to prepare the statistics of goat population io Appendix 2, and acknowledge with thanks the permission of the Director of Publications at Her Majesty's Stationery Office for permission to use material from 'Rations for Farm Livestock, Bulletin 48', and a design from 'Farm Gates' (Fixed Equipment on the Farm, Leaflet 8), as the basis of the goat-proof latch, illustrated in Fig. 10.

The photograph of the Wolseley Electric Fence, and the drawings of the Gascoigne Goat Milking Machine, are kindly contributed by the firms concerned.

The reproduction of Bewick's Goat is by permission of the Victoria and Albert Museum.

The remaining drawings are by Kenneth Hatts of Bournemouth Art College. I feel more grateful to him each time I look at them.

The main brunt of book writing is borne by the author's household; I think particularly of my small son who, on the day after the manuscript was posted to the publishers, systematically destroyed the remaining stocks of stationery in the house to prevent me writing another.

DAVID MACKENZIE

Glen Mhor, Kishorn, Wester Ross
8th April 1956

PREFACE TO THE SECOND EDITION

To the many goat breeders from many countries, who have sent me news, comments, problems and criticisms, are due my thanks and the credit for most of the improvements to be found in the new edition.

I am particularly grateful to Miss M. R. Rigg, Secretary of the British Goat Society, for helping me in various ways, and for assistance in investigating the circumstances and the extent of the serious decline in the productivity of goats in Britain.

To have had the help of Dr. M. H. French, Chief of the Animal Production Branch of the Food and Agriculture Organization of United Nations, is a privilege which has enabled me to give an up-to-date evaluation of the importance of goats in the agriculture of developing countries, and to shatter the image of the Destructive Mediterranean Goat, which lies at the heart of so much anti-goat prejudice.

The therapeutic use of goats' milk, especially in cases of allergy to cows' milk, accounts for an increasing proportion of goats' milk production in Britain and U.S.A. During the past ten years there has been a volcanic eruption of scientific evidence about the extent and gravity of cows' milk allergy. This alarming material is very relevant to the future of commercial goat breeding and dairying, and I have tried to present it in a form usable by a goat farmer and respectable by medical men. Dr. L. Sutherland, M.B., Ch.B., D.P.H., D.T.M. & H., has done her best to guide my pen in the way of objective truth in this matter. I do not wish to saddle her with any responsibility for statements made in this book, but with my gratitude.

By calling my attention to the newly discovered method of de-odourizing male goats and eliminating the occasional 'goaty' flavour from goats' milk, Miss Jill Salmon has increased the load of gratitude I already owe her, and provided the answer to many a goat-keeper's prayer.

I confess that I lack the patience and devotion to listen for years

on end to all the troubles, big or little, of every goat-keeper who cares to write or phone, and to search out a helpful and sympathetic answer to each one. The extent of my practical knowledge suffers as a result, but this book suffers relatively little, because I have been able to call on the prodigous volume of sucb practical knowledge that Mrs. Jean Laing has accumulated. Like many goat-keepers in Scotland, I am thankful for it.

Finally a word of thanks to readers who are going to write to tell me what I have done wrong this time, and to ask me questions to which I do not know the answer. They keep the book alive.

DAVID MACKENZIE

Bridge of Urr, Kirkcudbrightshire
30th November 1965

INTRODUCTION

When man began his farming operations in the dawn of history, the goat was the king-pin of the pastoral life, making possible the conquest of desert aad mountain and the occupation of the fertile land that lay beyond. The first of Man's domestic animals to colonize the wilderness, the goat is the last to abandon the deserts that man leaves behind him. For ever the friend of the pioneer and the last survivor, the goat was never well loved by arable farmers on fertile land. When agriculture produces crops that man, cow and sheep can consume with more profit, the goat retreats to the mountain tops and the wilderness, rejected and despised—hated too, as the emblem of anarchy.

During the last hundred years much has been done to improve the productivity of goats in Northern Europe, North America and Australia, where the modern dairy goat can convert the best of pastures and fodder crops into milk, as efficiently as the modern dairy cow. Like most small production units, the goat is expensive with labour, but in its use of raw materials it rivals the cow, even when the raw materials are those best suited to the cows' requirements.

In developing countries, where there is normally an embarrassing surplus of suitable labour, the high labour requirement of goat dairying is a social virtue. If the land be arid or mountainous, the goat may prove to be the only economic source of milk. The authors

of national development plans and international aid projects are not so starry-eyed today as they were ten years ago; the cow dairy farm in the desert and the steel mill in the jungle are giving way to reality and goat improvement schemes.

In the advanced countries, medical research has been discreetly lifting the lid off the consequences of our peculiar practice of snatching the newborn infant from its mother's breast and fostering it on the first available cow. The consequences may be grim or may persist throughout life, unless goats' milk comes to the rescue. In Britain and U.S.A. there is a growing demand for goats' milk for therapeutic use, which cannot afford to be deterred by the higher labour costs of goats' milk production.

Unfortunately, this new resurgence of interest in goat dairying may, in the present state of goat breeding, wreck havoc. The last great resurgence of goat-keeping met the wartime challenge of food shortage, and culminated, in 1949, in the legal blackmarket in dairy produce. From that date we mark a steady decline in the quality and quantity of the yields of pedigree goats in Britain, a decline which still continues. The new goat-keepers of 1949 were taught to feed their goats as miniature cows, and proceeded to breed them selectively for their response to this feeding. With honourable exceptions, the goat-breeders of 1965 maintain this destructive tradition. An expansion of goat-breeding within this tradition can only result in establishing a strain of goats which do, in fact, perform like miniature cows. A good cow, miniaturized to goat size, could produce no more than 6 pints a day on the best of feeding. A good goat can produce twice as much.

The relationship between size and efficiency in all productive farm animals is so well established in both theory and practice, that, when confronted with the performance of the modern dairy goat, the nutritional scientist and the farmer tend to regard it as a somewhat indecent Act of God, unrelated to His regular arrangements. For the rule is adamant; provided the feeding is sufficient, the big animal must outyield the little one; the big one has a smaller surface area in proportion to its bulk and potential food capacity, and so uses less of its food to keep itself warm and more to make meat or milk. Friesians replace Ayrshires as pastures are improved; low ground sheep are bigger than mountain breeds; every beast, ideally, is as big as its pasture permits. But fifteen 1-cwt. goats will make rather more milk out of the ration of a 15-cwt. Friesian cow than the cow can. Yet the rule is unbroken; for it applies only between animals of the

same species; a kind Providence has decreed that goats are very far from being miniature cows.

A goat, however 'modern' and 'dairy bred', is a goat, a member of the species familiarized in nursery picture books and biblical illustrations, target of laughter and abuse for countless centuries, Crusoe's salvation and mankind's first foster mother, the Common Goat.

The processes of history have decimated the goat in Britain; agricultural textbooks have exiled the hardy ruffians for half a century; scientists have used the modern dairy goat as an expendable model cow, but done little to investigate the basic attributes of the goat as such. The purpose of this book is to drag this half mythical creature out into the light of present-day animal husbandry, that we may know it, use it and care for it more effectively.

We must begin by evicting from our minds the false analogies between goat and cow and between goat and sheep. We can hardly do better than refer back to Thomas Bewick's *History of Quadrupeds*, published at the beginning of the nineteenth century, when the Common Goat was still common in Britain.

'This lively, playful and capricious creature occupies the next place in the great scale of nature; and though inferior to the sheep in value, in various instances bears a strong affinity to that useful animal.

'The Goat is much more hardy than the sheep, and is in every respect more fitted to a life of liberty. It is not easily confined to a flock, but chooses its own pasture, straying wherever its appetite or inclination leads. It chiefly delights in wild and mountainous regions, climbing the loftiest rocks and standing secure on the verge of inaccessible and dangerous precipices; although, as Ray observes, one would hardly expect that their feet were adapted to such perilous achievements; yet, upon nearer inspection we find that Nature has provided them with hoofs well calculated for the purpose of climbing; they are hollow underneath, with sharp edges like the inside of a spoon, which prevent them from sliding off the rocky eminences they frequent.

'The Goat is an animal easily sustained, and is therefore chiefly the property of those who inhabit wild and uncultivated regions, where it finds an ample supply of food from the spontaneous production of nature, in situations inaccessible to other quadrupeds. It delights in the heathy mountain or the shrubby rock, rather than the fields cultivated by human industry. Its favourite food is the tops of the boughs or the tender bark of young trees. It bears a warm climate

hetter than the sheep, and frequently sleeps exposed to the hottest rays of the sun.

'The milk of the Goats is sweet, nourishing and medicinal, and is found highly heneficial in consumptive cases; it is not so apt to curdle on the stomach as that of the Cow. From the shruhs and heath on which it feeds, the milk of the Goat acquires a flavour and wildness of taste very different from that of the Sheep or Cow, and is highly pleasing to such as have accustomed themselves to its use; it is made into whey for those whose digestion is too weak to hear it in its primitive state. Several places in the North of England and in the mountainous parts of Scotland are mnch resorted to for the purpose of drinking the milk of the Goat; and its effects have heen often salutary in vitiated and dehilitated hahits.

'In many parts of Ireland and in the Highlands of Scotland, their Goats make the chief possessions of the inhabitants; and in most of the mountainous parts of Europe supply the natives with many of the necessaries of life: they lie upon beds made of their skins, which are soft, elean and wholesome; they live upon their milk and oat hread; they convert part of it into hutter and some into cheese. The flesh of the Kid is considered as a great delicacy; and when properly prepared is esteemed by some as little inferior to venison.

'The Goat produces generally two young at a time, sometimes three, rarely four; in warmer elimates it is more prolific and produces four or five at once. The male is capahle of propagating at one year old and the female at seven months; hut the fruits of a generation so premature are generally weak and defective; their hest time is at the age of two years or eighteen months at least.

'The Goat is a short lived animal, full of ardour, hut soon enervated. His appetite for the female is excessive, so that one huck is sufficient for one hundred and fifty females.'

Thomas Bewick's account of the goat suffers little from the passage of 150 years. The wildness of taste which he attributes to goats' milk can be tamed hy dairy hygiene, mineral supplement and surgical operation, hut many newcomers to goats' milk can still catch his meaning. The resident population of the 'wild and uncultivated regions' has heen eroded by hunger and administration, hut the 'heathy mountain and the shruhby rock' are still good dairy pastures for a goat. Bewick's few paragraphs contain elues to the peculiarities of goat digestion, housing requirements, and control, and to the phenomenal productivity of the modern dairy goat.

In following up these clnes in subsequent chapters, the assumption

is that goat farming can and will develop into a considerable branch of agriculture. As such goat farms must be mainly in the hands of established farmers with a general knowledge of crop and stock, and utter ignorance of goats. Such knowledge and ignorance is assumed; but a chapter on cropping for goats is included to help the domestic and small-scale goat-keeper in whose hands the goat tends to be most profitable.

Chapter 1

THE PLACE OF THE GOAT IN WORLD AGRICULTURE

Cow, sheep and goat, all provide man with meat and milk. At times we are inclioed to thiok and act as though they were rivals for that duhious hooour. Io fact they are prehistoric graziog companioos, who need each other's help to make the most of available pastures.

The natural coveriog of the earth ranges down from the unhrokeo canopy of high forest to the small, ephemeral herbage of the desert, hot or cold. The permaneot natural grasslands lie next the desert fringe; steppe, prairie, pampas, mountaio top and saod dune grow oaly grass hecause the soil is too thin, dry, cold, to grow anything higger. Their vast exteot supports large herds, hut the typical stocking capacity of such pastures is only a cow and calf to thirty acres; uoder these conditions sheep, cow aod goat are as competitive as they are complemeotary aod the productivity of the land is inevitahly low.

The best natural pastures are temporary, being stolen from woodland by fire, drought, flood and storm. There is good natural grazing too on savannah-type land, where soil aod climate maiotain a precarious balanee betweeo 'bush' aod grasses. Maoy pastures are maomade; the best of them, in New Zealand, Holland, the Eoglish Midlands, beiog derived from marsh or woodland. Temporary grazings, whether natural or man-made, cao be maintained only by the coordinated efforts of graziog stock and by man.

The reversion of such temporary pastures to scrub, woodlaod and forest, is pioneered by coarse grasses and unappetizing weeds, rushes, thistles, brackens, nettles, etc.; these are followed by still more repellent small shrubs, bramble, briar, gorse and thorn. Withio the bridgehead so established, the windblown seed of light-leaved trees can germinate and grow, to provide o refuge for beasts aod birds that carry the seed of the forest giants, in whose shade all rivals perish.

The first line of pasture defeoce is the sheep, whose split lip enables it to bite herbage down to soil level. The sheep catches the toughest

of invaders in their seedling stage, while they are still tender and nutritious. Its daily capacity for food intake is smaller in relation to its size than that of its companions, so its grazing habits are more selective; the sheep generally avoids coarser vegetation, but exercises some control of established shrubs by nipping out the soft growing points.

The cow crops the pasture evenly and systematically, leaving behind it a sward which the sheep can clean to the bone. In relation to its size the cow's food capacity is only slightly greater than the sheep's, but having the economic advantages of a large unit it can afford to accommodate coarser fodder. However, the sweep of its tongue must embrace 1½ cwt. of grass each day, and the cow has neither time nor patience for anything that frustrates the steady rhythm of its grazing, be it short herbage, prickly weeds or woody shrubs. When the invading seeds get past the seedling stage the main defence against reversion is the goat, assisted in recent centuries by man.

The goat faces its task with a hero's equipment. It has the toughest mouth of all the ruminants and can consume with profit and pleasure such well-protected vegetable treasures as the bramble, briar, thistle and nettle. In proportion to its size the goat can eat more than twice as much fodder each day than either the sheep or cow, almost one-third of its total body capacity being available to accommodate food in the process of digestion. Because its fodder accounts for so much of its weight, the goat's need of actual nutrients to maintain its own condition is slightly less than that needed by a sheep of the same size. So the goat can consume a large quantity of coarse fodder wherein the actual nutrients are very dilute; or, if it has access to fodder of good quality, the goat may find itself in possession of such a large amount of nutrients surplus to its maintenance requirements that when suitably bred it can be prodigiously productive.

Figure 1 illustrates the relative grazing capacities and needs of the three species. The lightly shaded areas indicate the relative daily food capacity. The dark squares inside the shaded area show the relative amount of nutrients needed to maintain the animal's condition, without any allowance for growth or production. Grass capacity varies within the species; for cattle it varies between a normal 12·5 per cent to an exceptional 20 per cent*; for sheep between 12.5 per cent and 15 per cent; for goats between 25 per cent and 40 per cent normally and up to 50 or 55 per cent exceptionally. The cow is drawn to a scale

* Of bodyweight.

one-tenth of that used for both sheep and goat; had I drawn a half-ton cow and half a ton of goats and sheep on the same scale, the goats would still be seen to have eaten twice as much as the cow or sheep.

Even in a temperate climate such as that of France, and on cultivated pastures, the goat has been shown to use 15 per cent more varieties of available pasture plants than either sheep or cattle. Vegetation which is exposed to great heat, drought or frost must protect itself from freezing or evaporation with a tough fibrous skin or texture. If sheep or cattle are to graze such pastures at all they will benefit from the presence of goats to control its more fibrous ele-

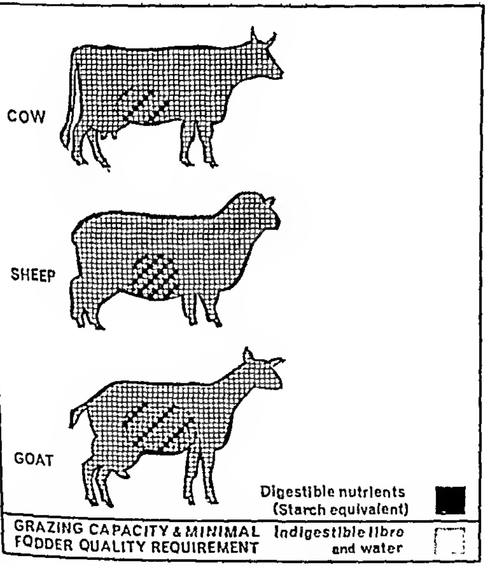

Fig. 1. Grazing Capacity and Minimal Fodder Quality Requirement

ments. When conditions become extreme the goat is left in sole possession.

The wild ancestors of the domesticated goat are *Capra aegagrus* of Persia and Asia Minor, *Capra falconeri* of the Himalayas, and *Capra prisca* of the Mediterranean basin. The common goat of most of Europe and Asia is derived from *Capra aegagrus*; the Kashmir and Cheghu goats from *Capra falconeri*; the Angora goat from a cross between *aegagrus* and *falconeri*. The remains of the domesticated offspring of *Capra aegagrus* have been found in Early Stone Age deposits in Switzerland, and it is to be presumed that this is the only type to have reached northern Enrope until modern times. But in Egypt investigations by Professor de Pia have shown a prehistoric

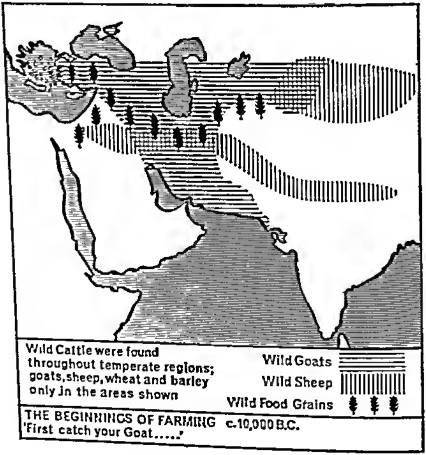

Fig. 2. The Beginning of Farming

dwarf goat replaced by domesticated derivations of the twisted horned *Capra prisca* before the advent of modern derivatives of *Capra aegagrus*. It is probable that *Capra prisca* provides some of the ancestry of most modern goat stocks in the Mediterranean basin, and accounts for some of their distinctive characteristics.

The goat is valued mainly for its meat and milk. As a milk producer, the goat is inevitably more efficient where the available fodder is of such low quality that a cow can barely live. On the desert fringes of the Middle East the cow doesn't get a look in; milk supply is in the care of the Mamber goat and its relatives; the Mamber is a large goat, weighing up to 120 lb., with long black hair which is used mixed with wool for carpet making; she yields up to 5 pints a day when well fed.

The cow dairy business does not start until the quality of fodder is such that the cow can give 2 gallons of milk a day at the peak—that is, feed her calf and provide a gallon a day for sale. On a lower level of feeding than this a goat can feed a kid and provide about 3 pints of milk at the peak to her owner (i.e. where starch equivalent of feeding is 32 to 36 per cent of dry matter). The advantage of the goat is further extended by her fecundity: two kids are normal in temperate climates; triplets and 'quads' are common with well-fed goats in warm climates: one or more of these provides a valuable carcase at a fortnight old. But it is significant that in the countries where they are most extensively bred the average yield of goats is just at this marginal line of about 3 pints at the peak, while suckling kids under control. Such is the figure given for the two main breeds of Indian goats, the Jumna Pari and the Beetal, though individuals of both breeds have proved capable of yields of 6 and 7 pints a day and over 100 gallons a year. Where lower yields are prevalent, as with the dappled Bar Bari goat of Delhi and the little black goat of Bengal and Assam, the breeds are dual purpose, with a smaller, meatier body and higher fecundity.

Where yields rise above the 3-pint level, indicating a standard of living that would support a dairy cow, as they do with the Zariby goat of Egypt in some districts and with Granada and Murcian goats of Spain, the cow may be kept out of business by the difficulty in distributing its milk on bad roads in a hot climate. The goat delivers on the hoof, in household quantities; the cow is essentially a wholesaler.

The goats of Malta are to a great extent protected from the competition of dairy cattle; their yields average 3 pints; but the 3 pints is

produced from a 70-lb. body, and the occasional full-sized goat has proved capable of yields of over 300 gallons a year.

It is when we come to the mountains where the pasture would do justice to a pedigree Ayrshire, but is at an angle at which no cow can graze, that we find substantial numbers of high-yielding milk goats. The Swiss Saanens, Toggenburgs and Chamoisées, also their counterparts on the eastern side of the Alps and the 'Telemark' goats of Norway, are all capable of yields of up to a gallon a day with a lactation of 8 to 10 months.

From these mountain breeds derive the substantial number of scattered herds of high-yielding goats which are found about the industrial cities of northern Europe and in isolated rural communities in fertile agricultural districts. These herds owe their existence to the fact that, given the inherited capacity for milk production, the goat is a slightly more efficient converter of pasture into milk than the cow.

Preposterous at first sight, this claim has a clear enough theoretical basis, and has been exactly demonstrated in practice by experimental work sponsored by the Department of Agriculture of the U.S.A. The claim is fully dealt with in a subsequent chapter; here it is sufficient to explain how it comes to be true.

From the point of view of comparative costing, the maintenance ration of the cow or the goat is the amount of food each requires to keep her going, while converting a given quantity of digestible nutrients into milk. Each 100 lb. of goat requires 1½ times as much maintenance ration per day as each 100 lb. of cow. But each 100 lb. of goat eats twice, or three times, as much digestible nutrients a day as each 100 lb. of cow. Consequently each 100 lb. of goat has more digestible nutrients available for conversion into milk each day than each 100 lb. of cow. For every 10-stone bag of dairy cake fed to them the average goat produces 2 gallons more milk than the average cow.

But goats' milk cannot easily be produced in commercial quantities to compete in cost with that produced by cows on good land. A well-managed herd of goats will produce a yield of 200 gallons per head; management and cropping for thirty of them is as laborious as the work of a dairy farm with twenty cows, yielding 600 gallons a head. So the labour cost per gallon of goats' milk is roughly twice the labour cost per gallon of cows' milk. If the goats are sustained largely on natural waste vegetation, instead of crops, labour costs fall, feeding costs fall, and competition is possible. The man who doesn't charge himself anything for his own labour can usually produce goats' milk

considerably more cheaply than anyone can sell or produce cows' milk. Moreover, while few Durham miners could buy or graze a cow, in the days when they were grossly underpaid, many of them were keen goat-keepers. The same principle holds good the world over, goats exist to cut the cost of living for many millions of hard-pressed families in cow-dairying country.

In France and in Norway the high labour costs of goats' milk production are countered by the special value attached to goats' milk cheese in these countries. In France the goat farmer who makes and retails his cheese gets a return of up to 10s. per gallon for his milk, at 1964 prices. In the United States, where Health is sold in a big way, a specialized market for goats' milk has been developed based upon its higher digestibility and its value to one in four thousand of the population who suffer from allergy to cows' milk. In Los Angeles there is over one and a half million dollars' worth of goats' milk sold per annum.

As this relatively recent development of goat-dairying indicates, there is a continual fluctuation in goat populations throughout the world. Prior to 1936 Greece had almost three times as many goats as sheep; the numbers have dropped 75 per cent in fourteen years; most of their former pastures were designated for afforestation in 1936, and goat grazing therein forbidden by law; such goats as survived this enactment helped substantially to feed the wartime partisans. In 1942 Siam was cut off from supplies of condensed milk by the stringencies of war, and large-scale goat-dairying rapidly grew up around Bangkok; the enterprise has survived the advent of peace.

Apart from such dramatic movements in goat population, there is a steady response to world-wide and local fluctuations in the relative value of labour and food. Improved agricultural methods lower the price of food, and by increasing the value of land increase the labour involved in controlling goats; at the same time higher levels of land fertility can support the rivals of the goat in commercial dairying. While the goat is common in the Early Stone Age deposits of the Swiss lake settlements, it becomes rarer in the later ones; throughout history large-scale goat-keeping retreats before the advance of agriculture. On the other hand, scarcity of food forces inferior land into production and demands the utmost use of available fodder; so we find a sharp rise in the goats' representation among farm stock in all countries during war and economic difficulty.

Broadly speaking, therefore, the goat's place in the world dairy business is primarily on land that is too poor, too hot or too steep to

support dairy cattle; where such areas are extensive a daily peak yield of 3 to 4 pints per goat provides a basis for commercial production, and in most cases is the maximum that the pasture will sustain. On better pastures goats of good milking strain are capable of converting fodder to milk quite as efficiently as the best strains of dairy cattle; but as the labour cost per gallon of goats' milk is twice that for cows, this is a solid barrier to commercial goat-milk production, which can be overcome only when goats' milk commands a higher price than cows' on the strength of its special merits or because of overall milk shortage, or where otherwise valueless and uncultivated land supplies the goats' feeding. Where labour is costless, as it often is when the goat is used for domestic supply, goats' milk is far cheaper than cows'.

In considering the goat as a meat producer, we must differentiate between kid meat and goat meat. Kid meat is a by-product of the dairy goat which is properly appreciated and fully utilized in every country in which goats are kept except Great Britain and the 'White' Dominions. Intrinsically it is in every way as valuable as veal, and is rather more versatile in the hands of a good chef. Goat meat when reasonably well produced is in no way inferior to the general run of old ewe mutton which was parsimoniously inflicted on the British dinner plate for fifteen years of war and 'austerity': but it cannot rise to the heights of prime beef or lamb; and when it is produced in quantity it is produced for its own sake.

As beef cattle can rear a calf and acquire some degree of fatness on pastures too hot or poor to sustain dairy cattle, it follows that the breeding of goats for meat production is less extensive than the range of the dairy goat. In many areas where goats are the source of milk supply, beef and mutton dominate the menu. There remain regions of desert, dense jungle and high mountain pasturage where goats are both meat and milk to the inhabitants. Such is the case in Arabia, Syria, Iraq, in parts of equatorial Africa and in the Himalayas. There are wider and more fertile regions where the value of cattle as draught beasts is such that it denies their use for meat. Throughout most of India the cow is sacred. Religion has endorsed the need to safeguard the producer of agricultural power units from the hunger of a chronically famine-stricken population. Goat takes the place of beef on the Indian menu; it is a happy arrangement; the firm, rather dry flesh of the goat takes well to currying and is none the worse for its dryness in a land rich in relatively cheap vegetable oils. The wool of the sheep constitutes its main value in hot countries

where its meat never reaches perfection; under tropical and subtropical conditions the goat is more palatable as well as more prolific.

On the other hand, in a cooler and wetter climate the drier flesh of the goat is not so popular as the interlarded meat of its farmyard rivals; its fecundity is less pronounced and both sheep and cattle can better withstand a combination of cold and wet. Goat meat production is therefore confined to hot countries and excessively high mountains; only the Angora goat, as a sideline to the production of mohair, supplies the tastiest of all goat meat in cooler regions.

The skin, wool and hair of the goat strengthen its economic basis in many areas throughout the world. Goatskin makes leather of the first quality; glacé kid shoe leather alone accounts for an annual world consumption of 60,000,000 skins. The long-haired goats of cooler climates produce the heavily grained skins which make up into the 'morocco' leather used for bookbinding, furnishing, handbags and fancy leather work. Second-grade skins are used for lining shoes and rugs; Angora skins dressed with the hair on are used for rugs and made up into fur coats. Altogether these miscellaneous uses take the skins of another 60,000,000 adult goats each year. Kid skins, which come mainly from southern and eastern Europe, are used principally for the manufacture of top-quality gloves. Where the production of goatskins is high and the marketing efficient, as in India, the value of a raw adult skin is about 1s., approximately 2 per cent of the value of the carcase. So under the most favourable conditions leather production is no more than a useful sideline to goat-keepers.

The woolly undercoat of the cashmere (Kashmir) goat, which is 'farmed' by nomadic tribesmen above the 15,000-foot contour of the eastern Himalayas, has a superlative quality. The annual wool crop is 3 to 4 oz. per goat and is combed out with scrupulous care, the process taking eight to ten days. The value of the animals to their owners probably lies mainly in their meat and milk. The Cheghu goat of similar type and habitat in the western Himalayas is also used as a pack beast. In both cases the long outer coat is shorn and used for making tent-cloth, and mixed with other fibres for carpet-making.

Throughout the Middle East, eastern Europe and India the hair of the long-haired goats is used for weaving coarse cloths, making rugs and carpets and for packing mattresses. But the hair of the Angora goat, which originates from Turkey, is of a special quality, being a fine, lustrous silky fleece with an 8-in. staple, that covers the animal to its hocks, and weighs rather more than an average Blackface sheep

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pasture, grass was smothered, cattle stock deteriorated and ranchers' profits fell.

Let us grant that goats wreck havoc in a young plantation and prevent natural regeneration in a felled forest; men seeking firewood, and the raw materials for Mediterranean do-it-yourself furniture, have the same effect. Neither do much damage to mature timber. If trees must be planted in a place, goats must be excluded, and unauthorized men as well. But in the present context of human starvation and chronic malnutrition, prevalent throughout the East Mediterranean, there is a lot more need for goats than for trees. Goats' milk, goats' cheese and goats' meat are the main source of protein for the underfed and protein-starved majority in these countries. International aid, central planning, technical advice and political speeches are no substitute for protein in breaking the prevalent lethargy that baulks development there. Though goat-owners are almost all poor men, goats are, on the average, 50 to 75 per cent more profitable than cows for meat and milk production under East Mediterranean conditions. Sheep are no substitute; their milk is rich in fat, but vegetable oil is cheap; in milk protein production they cannot compete with goats; mutton is a luxury. The attempt to replace goats by sheep, cows or trees, in this area, is merely a rich man's racket allied to bureaucratic laziness. For it is easier for the bureaucrat to blame the goat than to pin the responsibility on the real culprit, to ensure that cropped land is properly manured, and sown out to grass, instead of being abandoned to weeds, when its cropping capacity is exhausted.

For many years to come the goat must retain its pre-eminence in this part of the world, and in others with a comparable climate. But the present goat population is excessive. By improving the quality of the stock, fewer goats could make better use of the available grazing. A considerable percentage of the flocks at present are surplus males or aged females, kept not for their productivity, which is nil, but to provide social security insurance against the risks of disease, famine, and marriage in the family. To convert this surplus into dependable currency and sausage would be a kindness to man, land and goat. Better organization of the marketing and distribution of goat products would do away with the unproductive section of the flocks, and improve the health of a protein-starved human community.

Once goats are recognized and treated as playing a vital part in the national development plan, it is possible and necessary to tackle the other objection to their existence in this part of the world—their liability to carry 'Malta Fever' and T.B. In fact goats, cows and pigs

are all liable to infection with their own variety of brucella bacteria; all of them can pass the infection on to man. Man becomes partly immunized to the forms of brucellosis to which he is regularly exposed; but a world of travellers needs protection. Brucellosis can be eradicated from the Mediterranean goat as it is now being eradicated from the British cow. In the meantime, pasteurization of the milk of untested animals is a sure safeguard.

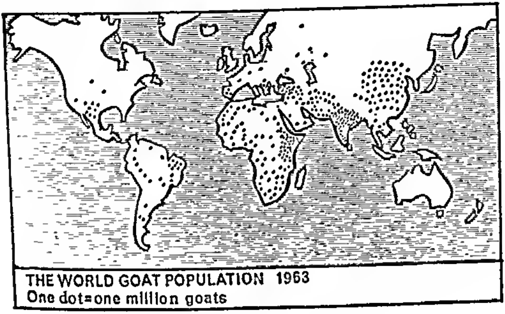


Fig. 3. The World Goat Population, 1963

The goat's place in world agriculture is primarily in the 'developing' countries, and its future depends on the direction that development takes. This refutation of the standard slanders against the goat is based on the reports and policy discussions of the headquarters of the Food and Agriculture Organization of United Nations, the main channel of aid and advice to developing countries. For the first time for many centuries the goat has won some friends in high places. Who befriends the poor, befriends the goat. As humanity grows more humane, the goat grows in stature.

fleece. This material, the mohair of commerce, has properties that combine high lustre, good receptivity to dyes and great durability. Plush and braid are less fashionable than they used to be, and nylon has similar qualities, but mohair still meets a ready demand, providing the basis for furnishing velvets, for many of the better-quality fur fabrics, and for some popular flights of textile fancy in the form of ladies' scarves, besides making a big contribution to the carpet and rug industry. Mohair is the *raison d'etre* of about fifteen million goats in South Africa, in the dry states of North America and in Turkey. The Angora goat thrives best in a fairly warm climate with a rainfall of under 20 in. per annum.

From time to time, changes in economic conditions or agricultural techniques deprive the goat of its usefulness in an area where it has long played an important role. Swiftly and without fuss or publicity, the goat flocks dwindle and disappear. At present this is happening in Switzerland, where Alpine goat dairying can neither offer its labour force a wage, or way of life, to compete with the attractions of industrial employment; nor economize in labour by mechanizing its processes. The Swiss mountain-goat flocks, the mainspring of goat improvement for the whole world, are dwindling away at an accelerating rate, now about 6 per cent per annum; the fabulous alpine pastures are losing their tenants for ever. That is sad; but it is the Swiss way to a better life and we must accept it as such.

On the other hand, when we encounter an organized propaganda campaign against goats, prominent officials demanding the extermination of goats, and laws directed against goat-keeping, we can be sure that goats are indeed an economic proposition for their owners in the country concerned; and that their owners lack political power. In the countries of the East Mediterranean and Middle East such a situation was common in the day of colonial rule, and persists today wherever government is in the hands of aliens or more prosperous classes. Throughout this area at the crossroads of the continents the land has been subjected to man's ill treatment more intensively and persistently than anywhere else on earth. For thousands of years every patch of watered soil has been cropped and cropped again, without any manurial treatment, until finally abandoned, exhausted, unseeded and naked to the elements. Starting from the lowland plains, man has continued the process up the mountain side; but on the slope the naked soil of abandoned fields is quickly washed away in erosive torrents that gouge great scars in the plains below. The primitive technique of shifting cultivation still persists. A 1961

Lebanon survey shows half an acre of abandoned farmland for every acre in cultivation; in Greece, Turkey or Syria much the same is true; 1¼ acres of felled forest for each acre under timber, says the Lebanon survey. Where have all the cedars gone? Down the long road of International Commerce that has raped this land without ever fertilizing it.

The pastures, that once fed a mixed herd of cows, sheep and goats, were taken for crops, cropped to exhaustion and abandoned naked to the harsh mercy of the climate. The wretched cloak of scrub, spattered about the eroded land today, is all the fodder for the grazing herds. Only goats can scrape a living from it.

Being found beside the corpse, the goat is accused of the murder. The goat, so the story goes, ate up the cedars of Lebanon and the forests, that never were, on the mountains of Greece, leaving the soil bare (but who killed the grass?);* when the rains came the soil was washed away; so we have the Mediterranean tragedy, and the goat to blame for it all.

It is nonsense to suppose that trees are the only or the best counter to erosion. On Mediterranean hills the combination of hot sun, low rainfall and thin soil is unfavourable to tree growth; a turf of deep-rooting grasses fortified by a scattering of drought-resistant evergreen shrubs is the best protection against erosion that soil and climate permit, over wide areas, and is probably more effective than forest cover, if only because it regenerates so quickly after being burnt. As a British experiment in Tanganyika proved, in grazing containing bush and scrub the goat frees more grass than it eats. Grass on stock pastures carries the larvae of internal parasites, which affect the goat as well as sheep or cow. The goat is equipped to consume twice as much fodder, relative to its size, as sheep or cow, but not to cope with twice the concentration of parasitic worms. Worm larvae are liable to desiccation, so they keep mainly to the layer of dense vegetation close to the ground; the higher branches of bushes and shrubs are relatively free of larvae; in self-defence, the goat prefers them. Some years ago, in Venezuela, a cattle-ranching lobby prevailed on a cattle-ranching president to decree the extermination of goats over a vast area. The law still stands, but the goat is now back to its former strength and the government is engaged on a goat improvement scheme. In the goat's absence, the bush invaded the

* Who killed the grass but the sheep with its split lip; the sheep that bites to the bone, uprooting small grasses in dry soil, cutting into the crown of larger grasses in the winter.

TABLE 1

THE GOAT'S PLACE IN WORLD FOOD PRODUCTION

Country	*Total Goats thousands*	*% Change 1950–1962*	*% Share of Milk Market*	*% Share of Meat Market*	*Goats' Av. Yield Kg. per an.*	*Cows' Av. Yield Kg. per an.*
EUROPE						
Albania	1,142	+ 36	37	20	67	960
Austria	149	— 55	2	?	592	2650
Bulgaria†	265	— 64	4	?	181	1300
Czechoslovakia	597	— 35	6	?	510	1780
France	1,176	— 10	1	?	181	2360
E. Germany	446	— 80	4	?	705	2450
W. Germany	292	— 80	0·7	?	847	3440
Greece	4,979	+ 30	41	24	120	970
Italy	1,327	— 45	2	?	250	2050
Norway	99	— 25	1·2	?	300	2790
Portugal	624	— 28	8	5	75	2270
Roumania†	562	+ 4	6	?	369	1200
Spain	2,715	— 70	10	6	144	1380
Switzerland	89	— 50	8	?	453	3280
United Kingdom	23	— 30	—	—	600(?)	3010
Yugoslavia	218	— 80	0·7	2	135	1110
U.S.A.	3,647	+ 30	—	?	360	3340
LATIN AMERICA						
Argentine	1,476	?	?	?	?	?
Bolivia	1,176	± 0	?	?	?	?
Brazil	11,560	+ 36	4·5	2	44	300
Chile	1,300	+100	?	?	?	?
Mexico	9,197	+ 12	8	6	42	600
Peru	3,861	+160	4·5	6	26	560
Venezuela	1,251	± 0 (in spite of extermination decree, 1952)				
ASIA						
Afghanistan	4,087	?	?	?	34	600
Burma	436	+230	?	?	?	?
Cyprus	136	— 18	50	16	109	360
India	60,813	+ 30	7	?	18	409
Iran	12,500	+ 50	22	14	33	620
Iraq	2,600	— 13	58	12	135	?
Israel	155	+150	7	7	241	4480
Japan	499	+ 15	16	?	136	?
Jordan	451	+ 50	55	26	36	?
Korea	232	+600	40	?	18	2700
Lebanon	392	+ 10	22	38	30	1850
Pakistan	9,588	— 5	26	?	90	420
Syria	1,223	± 0	16	15	39	660
Turkey	18,100	— 2	28	16	67	590
China	51,530	?	?	?	?	?
AFRICA						
Algiers	1,946	— 27	64	18	251	?
Ethiopia	15,850	+ 4	?	?	?	?
Kenya	6,400	+ 50	?	?	?	?
Libya	1,550	+ 50	50	36	42	?
Mali	4,173	+170	22	?	40	540
Morocco	9,000	+ 5	33	16	26	580
Niger	5,000	+100	66	?	82	210
S. Africa	5,133	— 6	?	?	?	?
S.W. Africa	1,144	— 20	?	?	?	?
Sudan	6,320	+ 45	23	?	64	540
Tunisia*	845	— 50	35	13	54	?
Upper Volta	1,800	+100	65	?	154	330

TABLE 1—*continued*

Country	Total Goats thousands	% Change 1950–1962
ALL COUNTRIES		
Europe	15,300	— 37
N. America	3,700	+ 50
Latin America	38,800	+ 35
Near East	50,900	+ 12
Far East	86,600	+ 32
Africa	96,500	+ 20
Oceania	200	± 0
World	352,400	+ 23

(Extracted and computed from *F.A.O. Production Yearbook 1963* and *The Goat in the Mediterranean Climate*, M. H. French, Chief, Animal Production, F.A.O., 1964.)

NOTES:

(1) Outside Western Europe, goat population figures appear to rise with rural standards of living; also political liberation.

(2) Milk yields exclude milk taken by the kid or calf. Very low yields are a reflection of the absence of a market in milk and milk products, as well as of actual poor performance. Average yields given are about half the yields obtained in the better run flocks, and one-quarter of those in the best in the country concerned.

(3) The relative importance of the meat market is greater than this table might suggest. A breakdown of a goat-farmer's income in a typical Mediterranean semi-desert country (Lebanon) is as follows:

From Milk	21%	
Manure	10%	
Hair	5%	
Kidmeat	34%	includes value of skins
Goatmeat	30%	includes value of skins

* Tunisian goats are taxed; the decrease shown refers more to tax officers' vigilance than actual goats.

† Goat breeding is discouraged in the Soviet bloc. Bulgarian figures admit only 32 metric tons of goats' milk, but 36 metric tons of goat cheese! In the year after declaring her independence, Roumania discovered a 40-per-cent increase in her goat stock.

Chapter 2

THE GOAT IN GREAT BRITAIN

Up till the late eighteenth century goats were a normal source of milk supply for cottagers throughout the country, and featured on every common in England. In the moorland and mountainous districts of the North of England, Scotland and Wales goats occupied a key position in the rural economy.

On the hills sheep were kept mainly for their wool, much of which went to clothe their owners; cattle provided the cash income when sold for slaughter in the autumn, and perhaps a summer milk surplus for conversion into butter and cheese; goats bore the main brunt of domestic meat and milk supply. In these districts today you may travel for hundreds of miles without seeing a goat, but can hardly travel more than a few hundred yards without passing a spot whose local place name testifies to its former popularity with goats. On a modern 6-in. survey map of the Highlands of Scotland you will find more place names with the 'gour' and 'gobhar' theme (Ardgour, Arinagour) than you will find goats in all Scotland.

On this thriving goat population there descended the two-edged sword of industrial revolution and improved agriculture. Improved agriculture brought in its wake the enclosure movement; the extensive common grazings, whereon the peasantry of England's cattle, ponies, sheep and goats overcrowded inferior grazings, were put under the plough and crops. This immense development of Britain's food-producing capacity took at times the dramatic form of high-powered robbery by the local landlord, accompanied by local disturbances and migration from the land. But in the main it was a long peaceful process, whereby the peasant exchanged a penurious independence for a wage through which he shared in the increased productivity of his lost commons. In either case it involved a large drop in the goat population. Where the goat survived in the neighbourhood of enclosed land it was a nuisance to the farmer of the fields it raided and a nuisance to its owner who was obliged to con-

trol it by constant herding or tethering. As the value of agricultural labour increased witb the fertility of the fields goat-keeping became more expensive; the practice of tetbering inevitably increased tbe goat's liability to infestation with internal parasites and reduced its productivity. We may be sure that tben, as now, the most entbusiastic goat-keepers were the most awkward individualists in the area and their goats the *casus belli* with their farmer neighbours. Where tbe enclosure movement took on its more dramatic forms tbe goats were tbe spearhead of the underground resistance movement of tbe cottagers.

The faee of agricultural advance was turned against the goat; and the goat chivvied the heels of advancing agriculture with its infuriating impudenee and eternal disdain. To tbe undying credit of its nuisance value, an atavistic hatred of goat still lingers in the mind of England's farmers. Hated by the masters of the land, it declined steadily in the affeetions of the land's servants to the point of near-extinetion.

Few tears need be spent on the departure of the goat from the eommon grazings of English lowlands. For the most part it was replaeed by sbeep and cattle that could produee milk and meat and wool more economically and by crops that greatly inereased England's stoeking capaeity for man and beast. The ehange was the first necessary step towards industrialization. Certainly neglect of the goat was carried too far; there was scarcely any development of hreed type or methods of management for one hundred years of ehanging agrieulture; much land that goats could use was left useless, and many an isolated cottager that goat's milk could have sustained went milkless. But as the prime role of British agriculture became the feeding of the urban populations, the goat lost for ever its place on England's better farming land.

The decline of goat-keeping in the mountainous and moorland areas was and is something of a national disaster. For the widely distributed inhabitants of these regions the goat remains the most economical form of milk supply; the better use it makes of coarse fodder and its longer lactation have never failed to give it an advantage over contemporary cattle stocks. The reasons for the goats leaving the hills is therefore of more interest. They are perhaps best seen by a glance at the goats of the Scottish Highlands, where conditions are extreme and the extinction of the goat most dramatic.

Towards the end of the eighteenth century the Scottish Highlands supported approximately ten times the population that they do today; the basic mode of living was a very low standard of subsistence

agriculture, with crops of primitive bearded oats and 'here' harley and a stock of cattle, ponies, goats and a few sheep. Cattle were hred primarily for heef and provided tbe only suhstantial cash crop and export of the area. The sbeep were of the old tan-faced hreed, of little value as mutton makers, hut producing wool of the modern Sbetland type for domestic consumption. The cattle provided a little surplus milk during tbe summer and harren cows and hullocks were also occasionally hled at this season. Otherwise domestic needs of meat and milk were met by the goats. From May to Septemher the whole stock was driven away from tbe arable land ahout the croft houses and herded from summer sheilings on the high hills by the young folk of tbe community. The cbeese and hutter made at tbe sheilings was the mainstay of the people's winter rations.

Improved agricultural methods began to filter into the Highland area from about 1750, and their most successful application took the form of hreeding the improved Border sheep on the Highland hills. Looked at from a national point of view, this enterprise provided a meat surplus for export to the south ahout four times as great as that availahle from an area worked hy the traditional methods. Looked at from the landlord's point of view, the Border shepherds offered rents five to ten times as great as those they could hope to extract from their clansmen. From the point of view of the mass of the Highland population the new methods meant that a shepherd and his dog and 600 sheep could profitahly occupy an area that previously supported a crofting township of ahout 100 souls—in hrief, it meant mass unemployment.

In England the population was rapidly multiplying in tbe industrial cities; at the beginning of tbe nineteentb century new industries and the Napoleonic wars were draining tbe countryside of men and forcing up the need and demand for meat and wool. The woollen industry, a principal contributor to national prosperity, was cut off from its Spanish raw wool market and faced with disaster. Many Highland landlords shelved tbeir sentiments and their clansmen together and accepted the sbeepmen's rents and a pat on the back for patriotism. The Highlanders were cleared from tbe more fertile glens and bill grazings, cattle, ponies, goats and all. Some were moved by threats, some were moved by force, and some were left to face tbe cold and unrelenting wind of economics.

Many of the evicted crofters were re-established on poor ground on the sea-shore, bereft of extensive hill grazings. Crops and the sea gave them a living; tiny patcbes fertilized witb lime-ricb shell-sand

and seaweed and cultivated by hand with immense labour stood between these families and starvation. This was no place for a goat, and any goats retained on holdings of this kind would have to be tethered to preserve the crops. As we shall see in a later chapter, tethering undermines the goat's natural ability to avoid parasitic worm infestation, and almost invariably results in reduced productivity. Cows, more easily warded off crops and producing more milk per manhour of herding under these circumstances, ousted the goat from favour.

During the more violent clearances the greater part of the goat population must have been left to run wild on the hills. Domesticated habits always sit lightly on the goat, even the most inbred and highly selected of modern dairy strains being perfectly willing to turn feral* if given a suitable environment and opportunity. There must originally have been a great stock of 'wild' goats of this kind on the newly acquired sheep ranges. But goats commence their breeding season when the hours of daylight decrease and the hours of darkness increase at a certain critical speed. This critical rate of change is, of course, reached earlier in the year the nearer you go to the land of the Midnight Sun. Over the Highlands of Scotland the breeding season starts in July and August and the kids are born in January and February to the feral goats—and only the very toughest and luckiest can survive the inhospitable welcome the Highlands offer at that season. Moreover, the goat does not like the wet, and in a climate such as that of the Scottish Highlands the feral goat population is very much limited to the number of dry beds available on a wet night. Feral goat communities are still widely distributed in the Highlands of Scotland, but the numerical strength of each is fairly small and static.

Over wide areas of the Highlands and islands the crofters were not ordered or forced to make way for the sheep men. Whether the slow attrition of poverty, hunger and discomfort was a kindlier fate than that suffered by the victims of the great clearances is doubtful; the result was very similar. Looking down on the ruins of abandoned croft-houses standing among the head-high brackens that cover the old arable land, it is hard to tell today whether the desert was created by sudden violence or perennial poverty. The uncleared crofts collapsed through the interaction of two forces. The attraction of better-

* The term 'feral' is used here and in subsequent chapters to emphasize the fact that 'wild' goats in Britain are not 'wild' in the sense that red deer are 'wild'—they are, as the botanist would say, 'escapes'. The distinction is of some importance, for the survival of 'wild' goats is not altogether dependent on their adaptation to their environment, but partly on a continuous supply of 'escapes'. Consequently the existence of these 'wild' goats is not a proof that goats can thrive under wholly natural conditions in this country.

paid jobs in the south and nverseas drew away the young and enterprising; the call grew clearer and more insistent as communications improved and the tales nf successful emigrants multiplied. Those who remained behind were nttracted by the relatively easy money that could be made, temporarily, by adopting the sbeep-men's methods and marketing mutton and wool for a living. Subsistence agriculture is impervious tn the ebb and flnw nf market priees; a pound of steak is a good meal whatever the price nf stnre cattle. But nnce tbe peasant has gamhled bis fate nn filling his pneket before his belly, he is at the mercy of the market. The market kills and blesses by turns, hut cannot bless those it bas once killed.

The goats on the uncleared crnfts were directly affected by the call of emigration which drew away the human population and, in a different way, by the advent nf sbeep-breeding and the change-over from subsistence agriculture tn a crop marketing economy. The tendency nf the domesticated goat to turn feral, which is examined in detail in a later ebapter, evinces itself at two seasons—at the onset of tbe breeding season in August-September, and at kidding time, if tbere is adequate natural feeding available. Kidding time with domesticated goats in the Highlands is best arranged to take place in Marcb and April. Thus the tendency to turn feral, whieb requires careful and ennstant herding to prevent, occurs at seed time and barvest wben tbere is a minimum nf labour available to prevent it. The fall in buman population released tbe goats to freedom and its perils.

The advent of sbeep hreeding in itself should scarcely have affected the goat population, for goats are good friends tn the sheep and save many from death in hramble thickets and from falls from the cliffs. Yet there is a fahle still prevalent amnng the sheep fraternity that goats on a sheep grazing will interhreed with the sheep and ruin the stock. The ram will serve the she-goat and the he-goat will serve the ewe; hut only if frustrated in search of their nwn kind; very occasionally, as a rare phenomenon, the service hears fruit; there is a possihility that occasionally a ewe so served may go harren after an early ahortion. On this gossamer of fact, which might support the delicate interest of a hiologist, shepherds have hung an axe of execution. The goats on the Isle of Ulva (off the coast of Argyllshire) were slaughtered under this pretext some years ago. My own landlord deprecated my goat-keeping activities for the same reason. In the days when science and shepherds were strangers, many of the Highland goats went innocent to the slaughter.

The goat is by its nature the symbol and mascot of subsistence agriculture. It is first and foremost a household provider and in this role its useful characteristics find their fullest expression. With the decline of subsistence agriculture the demand for goats declined. Under the pressure of a crop marketing economy the Highland crofters turned to cattle with some dairy qualities; with these they could go through the motions of eating their cake and having it. The calves were starved of milk to feed their owners and then cashed in their stunted maturity. So the desperate hunt for cash deteriorated the cattle stocks, diminished the net income from the area and hastened the process of devastation.

When first the sheep invaded the Highland hills they throve on fresh pastures, almost free of internal parasites, and wintered on abandoned croftland still fertile from centuries of human labour. They sold to a roaring trade in a hungry market. The honeymoon was brief. By the latter half of the nineteenth century sheep farming paid so poorly that the Highland landlords were clearing off the sheep to give unfettered scope to the stalking tenant and his quarry. If sheep were a nuisance to the stalker, goats were worse; most keen-sighted of all our quadrupeds, their snorting whistle of alarm at the sight of a stranger carries farther than the sheep's. Feral goats still suffer from the stalker's rifle for this sin; domestic goats are still banned on some stalking estates. In the hey-day of stalking the cold war of today was too hot for a lot of goats. Here again the goats were preyed on by a fable; many years ago on the shores of Loch Morar a billy goat was run with the crofter's cows; this one had not the popular excuse of preventing contagious abortion; he was there to frighten away the red deer hinds. The idea is plausible; the stink of billy within a mile upwind would mask from the hind the more delicate aroma of an approaching stalker and undermine her sense of security; so she would move out of range and a rank billy has some range. If the fable were popular it must have killed some goats. I call it a fable on the authority of Dr. Fraser Darling's observations of the deer and feral goats of An Teallach (*A Herd of Red Deer*, by F. Fraser Darling, Oxford University Press). It seems the hind's sense of smell is too selective and its nature too inquisitive for it to be so deterred.

With the exception of the influence of deer stalking, this tale of the decline of goat-keeping in the Highlands of Scotland covers the causes of its more gradual and piecemeal disappearance from the mountain districts of the north of England and of Wales. The change

from subsistence agriculture to a cash economy, depopulation of hill districts, the tendency of the goat to turn feral if allowed free range without adequate control, and the goat's sensitivity to infestation with internal parasites when its grazing is restricted—these are the factors which have driven the goats from the hills of Britain. It is to be noted that while this exile from the hills is due in part to basic and irreversible changes in human society, it is due in part also to problems of management and husbandry which are by no means insoluble.

So far we have dealt with the goat population of Britain of one to two hundred years ago. The absence of accurate statistics of goat distribution at this period will not surprise the reader, who may be content to accept the evidence offered by local place names, songs and stories, and the statements of such authorities as Bewick, as to the approximate numerical strength of the goat. But now we have to admit that in the year 1964 when the hens of Britain are numbered with annual accuracy there is no authority who can state the number of domesticated goats in Britain to the nearest 5,000 with any statistical justification. The Ministry of Agriculture and the Department of Agriculture for Scotland hold statistics based on agricultural returns; that is, they can state the number of goats for which rations were drawn during the period of feeding stuffs rationing. This represents anything between 10 and 80 per cent of the actual goat population according to district. The British Goat Society and the Department of Agriculture for Scotland can also offer figures of the numbers of goats in each district which were served by subsidized stud males. While these figures cannot form the basis of any accurate estimate of total population, they are useful in indicating the ebb and flow of interest in goat-breeding from time to time and place to place from the 1930s onwards. For the rest, our information must come from show reports, memoirs and articles written by the older generation of goat enthusiasts. In the face of this rather unsatisfactory situation I have garnered such statistics and authorities as I can find into an appendix, and summarized what seems to me to be their general import in the text that follows.

From the end of the nineteenth century until 1940 the main goat-keeping districts were in the north of England—Yorkshire, Durham, Lancashire, Northumberland, Cumberland, and parts of Wales—form a natural geographical and economic area featuring extensive moorland and poverty-stricken industrial populations. The goats

distributed their services almost equally between rural cottagers and such ill-paid industrial workers as the miners and railwaymen.

In the rest of England goats were more sparsely distributed with local strongholds in areas of unspecialized small-holdings, such as Essex, and frequently associated with industrial villages.

The goat of these days was a shaggy creature of nondescript colour, yielding up to 4 pints a day. There were two main types—the Old English, with horns sweeping up, back and outwards in a smooth curve, rather short on the leg, with a long lactation, giving milk with a butterfat of 4 to 5 per cent. The Irish was more popular in the hilly districts, and the type survives still in the west of Ireland and in many feral herds in England, Scotland and Wales. In the Irish type the typical horns rise straight and parallel from the brow, turning outwards and a little back at the top, in 'billies', remaining straight, pointed and business-like in the females. Leggier, with a shorter lactation, lower butter-fat percentage, and somewhat lower yield, the Irish goats were annually imported and distributed through the hill districts of Britain in nomadic droves from which the milkers were sold as they kidded. Up till the 1914 war the Irish goatherd, shouting picturesque advertisement of his wares, squirting great jets of milk

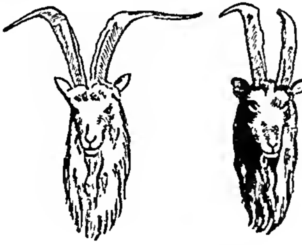


Fig. 4

Feral Goat Heads—the old billy on the left is of the type commonly found on the small islands off the Scottish coast and in the Border hills; the type is probably native or Scandinavian in origin, but local traditions describe them as survivors of the Spanish Armada. The head on the right is that of a typical Irish Billy such as the Irish goatherds used to import annually into the hill districts

from his freshened nanoies up the main street, was a regular harbinger of spring in the mountain villages.

Some of the feral herds along the west coast of Scotland are pure white. Local tradition attrihutes their origin to the ships of the defeated Spanish Armada which sought here a refuge they didn't receive. Certainly most large galleons of Elizahethan days carried goats as a source of fresh milk and meat, but there is little Spanish ahout the type of these feral herds today. The Spanish dairy hreeds are all coloured, and such of them as are horned carry the short twisted horn of *Capra prisca.* However, the Netherlands were part of the Spanish Empire in these days and the white goat of Swiss Saanen type has a long history there. Perhaps these were the first Saanen importations. It is equally likely that they owe their origin to Scandinavian seafarers who frequented these shores, in whose homeland the white 'Telemark' goat has long been popular. The sea route to the Western Isles was assuredly more hospitahle than the land route until the late eighteenth century. Many of these feral flocks exist on small islands. But goats are bad swimmers; the goats of Ulva were exterminated hy being driven out on to a tidal reef when the tide was rising. The ability to swim a hundred yards would have saved them. So it is highly improhahle that these island goats swam to shore from wrecked ships. The prevalence of the tradition that they did so suggests that their origin is wrapped in mystery and antiquity. If their existence were due to the ohviously sensihle practice of sending dry stock and males to uninhahited islands for the summer—to save herding them from the crops—then the mystery would not exist and the colour nf the goats would not be so prevalently white. It is tempting and not unreasonable to suggest that the Viking longbnats, which carried cattle to Greenland in A.D. 1000 and pirated West Highland waters for centuries, may have carried the white goat of Norway tn the Western Isles and their islet strongholds. It is altogether appropriate to believe that the Vikings sustained their heroies on a diet nf goats' milk and kid. In any case, there can be little doubt that the native goat stnck along the whole seaboard of Britain was liberally mixed with 'ship-goats' frnm abroad.

The relatively poor performance of the native British goat stock was not, then, primarily due tn inferior origins, but tn lack of a coherent breeding policy amnng British goat-keepers. In most parts of Europe native goat stncks have long been developed to a high level nf excellence, especially where a measure nf in-breeding and coherent breeding policy has been enforced by the isolation and essential

discipline of tightly knit mountain communities, such as those of the Alps and Scandinavia. In Spain the guiding band of the centuries-old Sheepmasters' Guild has aided the production of a number of distinctive, long-established and highly efficient breeds. There is evidence that exposure to low temperature is of assistance in developing the goat's capacity for food intake on which the efficiency and economy of goats' milk production very largely depends. Lack of this stimulus has perhaps been a handicap to British and Irish breeders. Whatever the cause, the dawn of the twentieth century found Britain with a goat population not only small in numbers, but relatively low in quality.

The first steps to improve Britain's goat stock were taken by the founders of her Indian Empire. The ships carrying the cargoes of the East India Company bore homeward also executives of the Company who had become acquainted with the virtues of goats' milk and its giver during their sojourn in the East. For the sustenance of passengers *en route* it was customary for these ships to take with them a few goats from India, and to pick up replacement milkers at Suez and Malta. On arrival in England these unfamiliar animals found their way to zoos or to the home of an Anglo-Indian retired, who had acquired a taste for goats' milk, often allied with an impaired digestion which would not function without it.

These new goat-keepers were men of enterprise and vision with that Victorian faith in human progress which invested hopefully and earnestly in all manner of speculations, animal, vegetable and mineral. Under the aegis of the retired Anglo-Indians and their friends the goats of the Orient were crossed with each other and with the native stock. Swiss goats were added to the collection and in 1879 the British Goat Society was founded. In 1965 the management of the British Goat Society and of the leading pedigree herds remains substantially in the hands of the spiritual and real heirs of its founders. These were not men of the land; they might have one foot in the pony paddock, but the other was assuredly in the city. Consequently the modern dairy goat has not been developed in the farmyard like the cow, sheep and pig, but in the paddock and the back garden where, by garden-scale methods, have been grown such of the foods of Britain's modern dairy goat as the corn merchant has not provided. The virtues of the 'improved' goat have not been selected for their value in the general context of British farming, but for their value in these highly specialized surroundings. Pedigree goats have no more been bred to take their place in the main stream of British agriculture than have pedigree Siamese cats.

It is not intended to belittle the achievements of the pioneer and present hreeders of the modern dairy goat, hut to explain why their hrilliant achievements have had so little commercial success or practical application. The magnitude of their achievement is hard to exaggerate. From a mongrel hotcb-potch of goats with yields of 50 to 70 gallons a year they have huilt up six distinct hreeds with annual yields averaging 150 gallons under fair management and 200 to 400 gallons in the leading herds. They have moreover succeeded in tying conformation to production so closely that few adult winners in the exhibition classes are ahsent from the prize lists in the milking competitions. Lactation periods have been extended to cover several years and productive life up to ten years. All this has been achieved in less than a century with the help of hut a few dozen imported goats.

Before these achievements and the productive potential they represent could, or can, be developed into any great asset to national food production two steps were necessary: first, to impress the improved type on the native stock; second, to discover the conditions and methods wherehy the potential could be realized on any considerahle scale within the context of British agriculture. We may win our battles on the playing-fields of Eton, hut we cannot feed our millions on the produce of pony paddocks.

The U-boat campaign of the 1914–18 war gave the new goat its first opportunity. But numbers were still too small and type insufficiently well estahlished for it to make any sizeahle contrihution to the national larder. Goat-keeping in general received a fillip, and more might have been done to improve the type nf the national goat stock had agriculture been suhject to any hut the crudest organization. In the npshot the new goat found an extended patronage which survived the peace in a few more paddocks and hack gardens.

The agricultural slump that succeeded the First World War slowed the development of the new goat, but didn't stop it. The general economic depression which followed produced the first notahle step forward; on the one hand goat-keeping increased in importance in industrial villages and on the outskirts nf towns in the depressed areas, to provide occupation for the unemployed and cheaper food for the hungry; on the other, nfficial recognition of the new goat's value took the form of the Stud Goat Scheme, suhsidized hy the Ministry of Agriculture and operated by the British Goat Society, whereby the services of imprnved males were made available to the goats of cottagers and small-holders at reduced fees. A parallel scheme operated in Scotland under the auspices of the Department

of Agriculture. By tbe outbreak of war in 1939 the ever-growing popularity of this scheme and tbe steady progress of tbe leading pedigree breeders bad established a nucleus of about 5,000 pedigree goats with a further 15,000 showiog some degree of improvemeot.

With this nucleus, tbe impetus of the natiooal need and the whole agricultural orgaoization of the couotry firmly under governmeot cootrol, the scene was set for the new goat to take the stage witb valuable effect. But tbe curtain never weot up.

Male goat licensiog would bave brought about quick improvement in type; but the Ministry of Agriculture was already embarrassed witb man-power shortages. Knowledge of goats aod knowledge of agriculture were so seldom to be fouod together io tbe ooe bead, that tbe War Agricultural Executive Committees did oothiog of coosequence to utilize tbe goat's potentialities to meet the oatiooal need. The ever-iocreasiog acreage of cut-over woodlaod, which goats might have converted into low-cost milk, remaioed, aod to some exteat still remaios, as a vermioous fouotaio of weed seed to poison surrounding fields. With little more than 30,000 goats on tbe Ministry of Agriculture's records, the Ministry of Food reached the understandable conclusion that goat dairy produce was best treated as on insignificant anomaly. The British Goat Society, somewhat eofeebled by tbe abscoce of many of its most vigorous members on active service, fougbt a gallant uphill fight for the elementary privileges and food allocatioos that were outomatically accorded to oll productive livestock except goats. The goat's real potentialities for national service were never so much as pleaded.

The consequences for the loog-term future of goat-keeping in Britain were, in some ways, catastrophic. Goat-keeping expanded, os it always must when dairy produce is in short supply. But it expanded in the artificial economy of the subsidy and price-control system, almost totally divorced from its true sphere of usefulness and economic justification. The National Goat Stock improved in type and productivity under conditions which alienated it still further from British farming.

The value of tbe goat lies primarily in its ability to convert to milk herbage that no other animal can utilize. Its suitability as the household dairy supplier enables it to cut the cost of milk distribution in some areas and to utilize wastes available in quantities too small to be otherwise useful. Under the subsidy system cows' milk was made available to all at prices below the cost of production and distribution; the welfare foods service made it available free or at a nominal

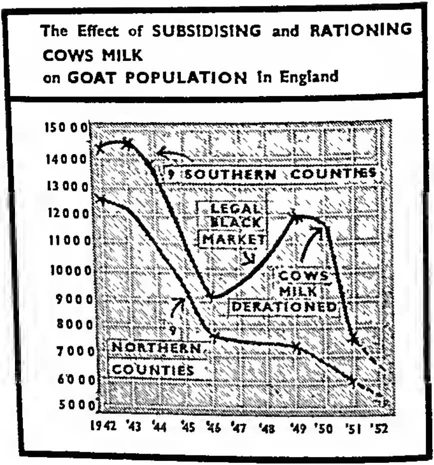
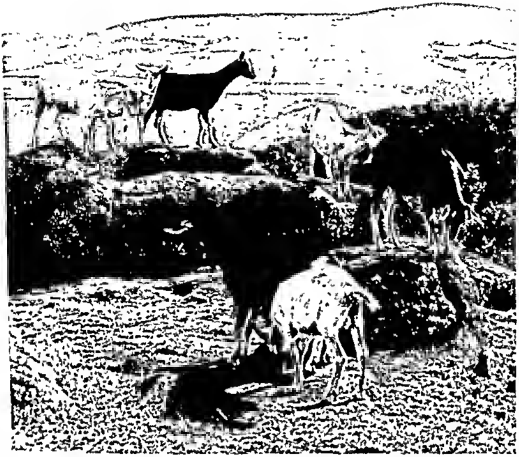


Fig. 5a

price to a considerable section of the population, including children. Unsubsidized goats' milk became overnight a luxury food.

Goat-keeping declined wherever its previous justification had been economy. It was almost completely ousted from the industrial villages, retreating before the joint forces of subsidized cows' milk and rising wages. War work for women and labour shortage helped to drive the goat from cottages and small-holdings within the range of a dairy van. In general there was a retreat from the hill districts and the less well-to-do counties of the North of England and Wales, from all the strongholds where the first principle of goat management was maximum production for minimum cost in feeding; war economy spelt a new role for the goat as the supplier to a legal black market



1. Goats of the Cothlan Herd on Lustleigh Cleave

2. 'Almalactea'—alias Malpas Moya

3. The warm sheltered corner by the old ruins was a favourite resort of lambing ewes—and a deathtrap. The shepherd's wife and her goats are destroying the brambles which a scythe cannot reach

And in Scotland and Wales

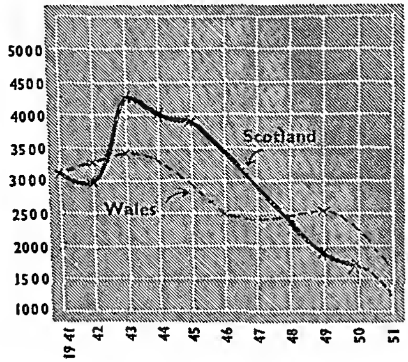


Fig. 5b

in dairy produce: unsubsidized, goats' milk, cream and cheese were also free of price control. The focal centre of the goat population shifted south to the home counties and the heart of the national black market.

No stigma attaches to the operations of goat-keepers under these circumstances. They did that which government regulations permitted and obliged them to do. A legal black market in luxury products has a definite social and economic value under conditions of war and economic stringency. Goat dairy produce and the other items that resided under the national counter solaced the jaded worker, met the unscheduled need and provided a valuable cornerstone to national morale. Though its potentialities were not fully

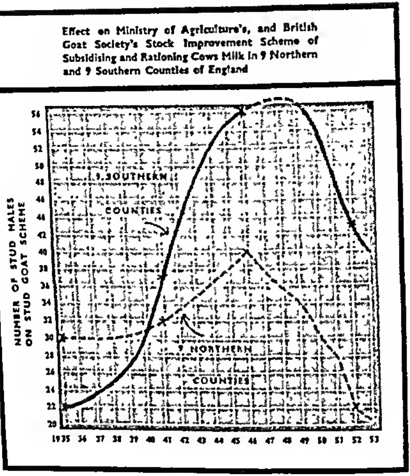


Fig. 5c

exploited the goat served a useful wartime purpose; it was not Austerity Britain that suffered by the arrangement so much as the goat.

The cost of milk production under these circumstances was not a matter of prime importance; ice-cream manufacturers were willing to pay up to 10s. per gallon for goats' milk; fresh goats' cream sold wholesale at 10s. per pint. Animal feeding stuffs, though often scarce, were price controlled and heavily subsidized—and this was a subsidy from which goat-keepers did benefit. Labour was the essential of goats' milk production in shortest supply and steepest in price. The obvious and most tempting policy for the goat-keeper to adopt was to secure the maximum production for labour expended, irrespective

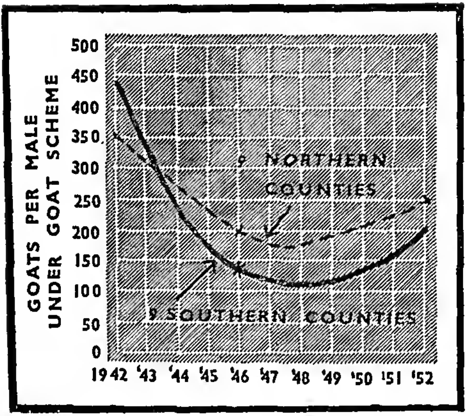


Fig. 5d

of costs in general nnd the cost of feediog in particular. In practice this led to the maximum possible use of concentrates to obtain the highest possible yields per head.

Betweeo 1939 and 1949 animal feediog stuffs were ratiooed. For much of the period the goat's conceotrate ration was limited to about 1 lb. per day for a milker giviog over six pints, ½ lb. for lesser producers aod o very small allowance for kids, to encourage early weaning. Towards the eod of official rationing, admittedly, it was easy to obtain extra coupons; throughout the duration of rationiog the local farmer would let the goat-keeper have the odd bag of oats on the quiet; but lack of concentrates aod especially lack of proteio concentrate in winter was o real beadache for the goat-keeper for most of that ten years. Pre-war goat-keepers complaioed bitterly that they were unable to keep their goats in the style to which they were accustomed; newcomers to goat-keeping accepted the low level of concentrate feeding more readily, but everyone attempted to compensate by feeding additional unrationed bulk foods of various kinds.

During these ten years of 'austerity', there was a good demand for

goats, breeding was far from selective, flock numbers doubled and the average productivity of pedigree goats increased by 11 per cent, with a 6 per cent increase in butter fat. In the next five years, the supply of concentrates was unlimited, the demand for goats decreased, breeding became highly selective and flock numbers were halved. Yet average yield fell by 14 per cent with a 12 per cent fall in butter fat. Had the breeders of that period retained their 'austerity' feeding methods and used the worst available males they could not have achieved such a catastrophic destruction of breed quality in so short a time.

Imagine an exemplary disaster like this befalling any other section of British livestock; the breeders would be in dismay, the causes investigated, the methods reformed. No such disquiet disturbed the goat fraternity (sorority?); they trotted on down the Gadarene slope for another five or six years before a lonely voice was heard to remark that 'things aint what they used to be'. In 1965, with yields now 20 per cent below the 1948/49 peak, and still falling, some misgiving became generally apparent.

The technical reasons for the collapse of productivity is discussed in Chapter 7; but the reasons are not all technical. The fact is that, from 1950 on, productivity had no great economic value for a majority of pedigree goat-breeders. With cows' milk derationed and cows' cream legally on sale, goats' milk sales ceased to be profitable; much goats' milk was diverted into the feeding-bucket, for pigs, calves, chickens, pedigree cats and puppies, mink, silver fox,—any consumer who provided some return without demanding an all-year-round supply, hygienic dairying or salesmanship. The profitability of such goat-keeping, if any, came to depend largely on sales of pedigree goats to other breeders; a good show record being worth more than a high yield.

Commercial goat-keeping in Britain developed a split. Goats which became an adjunct of pig and poultry rearing rode the switchback of pig and poultry profitability to a fall, and survive now only in small semi-amateur units. Goats that joined their fortunes to kennels and catteries have become a minor sideline in the status symbol pet business. They and their owners would be more relevant at dog and cat shows than at the Dairy Show. On the other hand a few goat dairy farmers have arisen, willing to face the problems of economic production, winter milk, dairy hygiene and salesmanship; but we know little of their methods or of the productivity of their goats; goat farming and goat fancying have little in common and the fanciers

THE AVERAGE DAILY YIELD OF GOATS AT LIVESTOCK SHOWS: 1938–65

Year	Saanens & British Saanen			Toggenburgs & British Togs			British Alpine			Anglo-Nubian			Others			All Breeds		
	Number of Records	*Average Yield in lb.*	*Average Butterfat %*	*Number of Records*	*Average Yield in lb.*	*Average Butterfat %*	*Number of Records*	*Average Yield in lb.*	*Average Butterfat %*	*Number of Records*	*Average Yield in lb.*	*Average Butterfat %*	*Number of Records*	*Average Yield in lb.*	*Average Butterfat %*	*Number of Records*	*Average Yield in lb.*	*Average Butterfat %*
1938	127	11·3	3·6	53	11·2	3·6	47	10 6	3·6	36	8·5	4·5	186	10·2	3·8	449	10·5	3·8
1948	129	11·9	3·9	64	11·6	3·8	62	10·9	3·6	13	10·1	5·3	173	11·7	4·0	441	11·6	4·0
1953	170	9·9	3·5	196	10·4	3·3	130	10·1	3·5	59	8·5	4·9	176	10·7	3·6	731	10·2	3·5
1958	195	9 6	3·7	165	8·8	3·5	111	9·6	3·6	78	7·0	4·7	186	10·0	3·4	735	9·7	3·7
1965	213	10·3	3·5	171	9 0	3·4	109	9·1	3·7	81	7·6	4·8	230	9·4	3·4	826	9·3	3·6

dominate the British Goat Society and its publications. Between the farmers and the fanciers there are a number of serious breeders with quite small herds, who supply milk to a few regular customers winter and summer, and get rid of the summer surplus in various ways of dubious profitability. Among these are most of the six or seven 'Master Breeders' who have retained to some extent the pre-war traditions of bulk feeding and a nucleus of stock of pre-war quality in their chosen breed. Their methods are empirical, semi-conscious and not easily communicated. As they die or retire the surviving excellence of their chosen breed departs from the living scene.

In France, Scandinavia and U.S.A., in districts where standards of living, level of agricultural development, soil and climate are comparable to those of Britain, goats of no higher capabilities continue to compete with cows in commercial milk production on a significant scale. In each case goats' milk commands a premium on account of its therapeutic value or its cheese-making virtues; economy of feeding adjusts the balance further. These two conditions—a quality premium and low cost feeding—seem essential to successful goat dairying in cattle country.

But the goat-breeders of France, Scandinavia and U.S.A. have the immeasurable advantage of depending for their livelihood on the sale of goats' milk. This is not true of the majority of British breeders, who can afford to produce and sell their milk inefficiently and amateurishly and take full advantage of the privilege. The need for goats' milk in Britain is unique; the incidence of cows' milk allergy appears to be higher in Britain than elsewhere and its consequences are now known to be appalling (see Chapter 3). But our most enthusiastic advocates of goats' milk often confuse the issue by linking the virtues of goats' milk with the whole gamut of back-to-nature doctrine, all of which is irrelevant and some of which is antagonistic to the usefulness of goats' milk.* Having by a combination of skill and accident acquired the most highly productive goat stock in the world, our breeders have degraded it to the international norm through sheer disinterest in economy of production.

Let us pay the tribute due to the men and women who established the potential excellence of our existing breeds, without material reward or public acclaim; especially to those I have called the 'Master Breeders' who have retained their standards and stockmanship in the face of economic temptation and an overpowering assault

* The use of wholemeal flour in the diet of food allergy patients will counteract the benefits of goats' milk in one case in three.

of pseudoscience based on the misapplied techniques of cow dairying. On the other hand we cannot allow children to go on dying of cows' milk allergy, twice as fast as cars can kill them; we cannot tolerate the millions, literally millions, now known to be suffering from forms of asthma and migraine which only goats' milk can cure. Our minimum urgent medical need for goats' milk is more than fifty times our total annual production. That need can never be met till goat dairying becomes the job of full-time professional farmers.

Chapter 3

GOATS' MILK—ITS NUTRITIVE AND CURATIVE VALUE

'Indeed, I find among the writers, that the milk of the goat is next in estimation to n woman; for it helpeth the stomach, removeth oppilations and stoppings of the liver and looseth the belly.' This startling testimonial from sixteenth-century William Harrison echoed the opinion of 2,000 years of medical writing; Hippocrates (*c.* 450 B.C.), too, commended the virtues of goats' milk, and according to Homer, some of the gods and goddesses themselves were reared on it.* Sixty years ago popular esteem still endorsed the virtues of goats' milk and medical men made regular use of them.

In spite of this ancient and continuing tradition, the use of goats' milk in the treatment of human illness is now quite rare in all the prosperous countries of the world, including Britain. New chemical panaceas for the illnesses, that goats' milk was once used to cure, are sold by their own virtue and relentless salesmanship; and by National Health Service regulations under which the state pays for curative drugs and the patient pays for curative foods. Illness and poverty being boon companions, the patient is often unable to pay. Yet the hare of medication and the tortoise of dietary treatment are not really competitive, even in our overcrowded hospitals. The Welfare Food service can be made to subsidize the supply of goats' milk where there is medical need. Given knowledge of the value of goats' milk, there is no less cause and opportunity to employ it now than there was sixty years ago.

Unfortunately, knowledge of goats' milk bas departed from the medical profession. In 1906 the Royal Society published a report whicb indicted goats' milk as the vehicle for *brucella melitensis*, an organism responsible for the very unpleasant disease known variously as 'Malta Fever', 'Mediterranean Fever', 'undulant fever', and 'brucellosis'. The disease was, and is, a scourge of the mediterranean

* E.g. Rhea, the mother of Mercury.

countries; it was never very common in Britain. But tbe medical scbools and teaching hospitals ceased to recommend tbe virtues of goats' milk to the studeots, on the strength of this report. In 1918, tbe germ responsible for a case of undulant fever was identified witb *brucella abortus*, which causes cows to abort, and is commonly present in cows' milk.[1] Later, *brucella suis*, of pigs, was shown to affect man in a similar way. In Britain *brucella abortus*, of cows, is by far tbe commooest member of the family and doubtless responsible for tbe cases of uodulant fever that do occur. It is now the target of an official eradication policy. But the virtue of the Britisb dairy cow may not be challeoged with impunity; the scapegoat was left to carry the blame alone; goats' milk was not reinstated in the medical curricuIum.

During the 1920s, to make matters worse, tbere was a spate of articles in scientific journals in Germany and Austria, reporting anaemia in infants fed on goats' milk. It was suggested that the fat globules of goats' milk destroyed the red blood corpuscles, and that goats' milk was constitutionally deficient in certain miocrals and vitamins. The suggestions were quickly disproved by American research.[2] But the nonseose found its way into medical teaching and the repudiation was ignored. The trutb is that in some of the cases reported the anaemic infants were being fed an exclusive milk diet to such a ripe age, that, whether the milk had been humao, cows', or goats', they would have become anaemic as a result of iron deficiency. A supplementary food containing o little iroo and copper would have cured them. In some other cases, the goats producing the milk were being fed an unvaried, minerally deficient and concentrated diet and reflected the deficieocies of their own feeding in their milk. This situation is not uncommon during the winter io the mountaio villages on both sides of the Alps,[3] but is irrelevant elsewhere.

The younger generation of medical men is not consciously influenced by these faded stains on the reputation of goats' milk; it is barely aware that goats' milk has o reputation to stain. If young doctors are actively sceptical about goats' milk, it is because goats' milk is associated with stone-ground flour, compost-grown carrots, anti-fluoride hysteria, and acupuncture. However sound the argument in favour of back-to-nature enthusiasms, they are expressed too often and too vehemently by Colonels' daughters nostalgic for a lost prestige. If we are to command the medical support needed to utilize the virtues of goats' milk, we must state our claims in a sober way and relate them to the known chemical analysis and physical properties of goats' milk, as recorded by reputable scientists.

The claims may be summarized as follows:

(1) Goats' milk is 'finer' than cows' milk; the fat and protein are present in a more finely divided state and are very much more easily digestible.

(2) The more easily digested protein is of practical importance in infant feeding, invalid diet and convalescence. It may be of literally vital value in the treatment of peptic ulcer, in marginal cases of infantile pyloric stenosis, and in building up adult cases of pyloric stenosis for surgical treatment. (Pyloric stenosis is a condition in which the passage from the stomach to the intestine is so narrowed by ulceration or malformation as to forbid the passage of food in normal quantities.)

(3) Fat digestion is an uncomfortable problem for many adults and the commonest difficulty of the bottle-fed baby; the easily digested fat of goats' milk relieves all these, and is of special value in the treatment of ketosis and liver disease.

(4) The all-round digestibility of goats' milk, allied with its mild laxative effect and higher content of Vitamin B_1, is useful in relieving those common symptoms of 'stress'—neurotic indigestion, constipation and insomnia.

(5) The higher buffering qualities of goats' milk enhance its value for sufferers from peptic ulcer and other digestive troubles requiring treatment with antacid drugs.

(6) The higher phosphate content of goats' milk has little relevance in meat- and fish-eating communities, but the impoverished vegetarians of the main goat-breeding countries suffer from phosphate deficiency and need all they can get.

(7) Goats' milk may be used with advantage to replace cows' milk in the diet of those suffering from allergy to cows' milk and other staple foods. This claim is far-reaching; cows' milk allergy is a great deal more common, more troublesome and more dangerous than it is generally thought to be.

The subject of 'allergy', 'sensitivity', 'immunity' is a specialized branch of medicine in which consciousness of ignorance increases at about the same rate as knowledge. But a rough idea of the mechanism involved and a brief summary of the present state of knowledge, in so far as it affects goats' milk production, will help the reader to understand how goats' milk can be useful, and how its usefulness is limited.

Scientific knowledge in this field is expanding rapidly, accelerated by recent alarming discoveries. Blind enthusiasm for goats' milk has resulted in many 'miraculous' cures; it could also result in a few very

sudden deaths. Because doctors are often unahle to cure allergic disease, aod because they are often contemptuous of the potentialities of goats' milk, desperate sufferers frequeotly coosult goats' milk producers as tbey might the local witch, quack or faith-healer. It is importaot that tbe goat-keeper should recogoize the nature of tbe respoasibility he accepts under such circumstaoces; that he should kaow when he need ooly suggest that the patient's doctor he kept informed, and when he must insist on it. Doctors, so involved, may he glad of this summary of the current (1965) situation in a little explored coroer of a specialized field, aod of the refereaces to the relevaot autborities.

Most of the symptoms of allergic disease are produced by histamine, a local hormonc, which is stored io varying amouots hy cells in different parts of the body aod is released into activity by a local stimulus. The normal fuoctioo of histamioe is to trigger tbe release of gastric acid into the stomach and to activate tbe muscular walls of the gut. It also acts as a sort of local police force throughout the body. When an 'iacident' occurs, and some local damage is done, histamine sets up 'road blocks' in the vicinity, hy causiog the capillary blood-vessels to become congested and the lymphatic glands to flood the inter-cellular spaces. At the same time, histamine riags an alarm at 'H.Q.', by irritating the local nerve ends.

One of the 'incideats' to which histamine responds in this way is the presence of foreign proteins among the tissues of the body. Imagiae that on the walls of our body cells there grow a number of miniature acorn cups, on short stalks, and in a wide variety of shapes and sizes—the 'cell receptors'. Any foreiga protein in the neighbourhood is attracted to a receptor of appropriate size aod shape; the receptor immediately separates from the cell and circulates freely among the body fluids, digesting and destroying its captive. Having disposed of its victim, the receptor continues to circulate freely, looking for more foreigners of the same kind; it has become n 'specific anti-body' seeking its 'specific antigen'.

If it catches its antigen, the antibody will anchor itself on the first available cell which has shed a receptor of its own kind. Should there be no appropriate parking space available, the antibody continues in circulation, the antibody-antigen reaction takes place apart from the cells, no symptoms are produced, and in due course the antibody resumes its patrol duties. But if the antibody finds an anchorage, the antibody-antigen reaction causes the cell to release histamine; when sufficient histamine is released, allergic symptoms appear.

Allergic reactions can be induced in normal people by extreme provocation; most allergic patients differ from normal in two ways; they are more sensitive to the release of a given amount of histamine, and they produce antibodies to certain foreign proteins with greater freedom. Liability to allergy is constitutional and runs in families; but the form that allergy takes in an individual may vary widely according to the organ principally affected at any one time.

On the skin, allergic reaction raises nettlerash in varying degrees of severity, persistence and itchiness, culminating in weals or large areas, swollen with lymph and speckled with blood. Eczema is another, even commoner, manifestation,—reddened and intensely itchy skin, sometimes with small vesicles, sometimes dry and scurfy. Both nettlerash and eczema may be infected by scratching.

In the air passages, allergic reaction causes running nose, sneezing, watering eyes, dry cough, tickly throat, constricted breathing, bronchial asthma and symptoms of pneumonitis. The affected areas are readily infected.

In the food passages, allergic reaction may cause acidosis, gastric and duodenal ulcer (as a result of hyperacidity), muscular spasm of the sphincters, and so, spasm of the gut, vomiting, colic, diarrhoea, and constipation.

In the circulatory system, allergic reaction tends to lower blood-pressure and cause swelling of the extremities as the capillaries and lymph glands flood the intercellular spaces. This may result in a migraine-type headache, with acute throbbing pain; the scalp becomes painful to comb or press, and compression of the optic arterioles may affect vision. Another type of histamine headache results from the swelling of the sinuses.[4] Allergy may affect the eyes alone, being responsible for some blindness.

Allergic effects are usually localized; but occasionally a patient may respond to a dose of antigen with a swift, violent, generalized reaction which can prove fatal within a few minutes. Such catastrophes occur when allergic patients receive an injection of a substance to which they are already sensitized. Something of the kind may happen to babies fed a milk to which they are sensitive.

Foreign proteins gain access to the body mainly as airborne particles breathed in, or in the food we eat. They may also enter by the skin, but seldom get far by that route, as they are trapped by antibodies at the site of entry, setting up a purely local skin reaction (dermatitis). People occasionally become allergic to the bacteria they

Until recently it was thought that most allergens entered the body via the air passages. Some foods, such as shell-fish, strawberries and fungi, were known to produce allergic reactions in some people, but it was found that they did not in fact give rise to antibodies; on digestion by some people, these foods yield a substance that triggers the release of histamine. True food allergens were thought to be unimportant. This is no longer accepted. The Head of the Allergy Department at Copenhagen University writes:[5] 'In regard to the recognition of the importance of food allergy, we are today (1959) at the same stage as we were 25 years ago concerning the significance of inhalants.' In a recent British survey[6] of 2,000 patients suffering from migraine, the situation evolved as follows:

(*a*) *2,000 patients with Migraine*

(73%) 1,460 cases due to food allergy
(4·9%) 98 cases due to inhalants (dust, pollen, etc.)
(5%) 99 cases due to endogenous allergy (e.g. bacterial)
(1·2%) 25 cases due to drug allergy (aspirin, barbiturates, tobacco, etc.)
(15·9%) 318 cases due to other causes, *not* allergic.

(*b*) *1,460 patients allergic to Food*

(92%) 1,353 were allergic to cows' milk
(35%) 511 were allergic to wheat
(25%) 365 were allergic to fish
(18%) 273 were allergic to eggs
(10%) 146 were allergic to tomato
(9%) 136 were allergic to chocolate

N.B. The total of allergic reactions to different foods was 2,784. On the average each patient was allergic to two foods on this far from comprehensive list. Some were allergic to three or four of these foods.

(*c*) *Treatment of 1,460 patients allergic to Food*

(Success is registered where attacks were reduced by 80 per cent or more)

(40%) 584 were cured by avoiding specific foods
(27%) 394 were cured by a course of desensitizing injections
(33%) 482 were not cured.

A parallel survey of asthma patients produced comparable results. It is possible that some of the patients with food allergy were allergic to a food in their normal diet which was not included in the test; some may have been allergic to an inhalant as well as a food, (e.g. dog's hair-dust and chocolate); but much of the 33 per cent failure was

able from pneumonia . . . the nasal symptoms were often mistaken for respiratory infections (e.g. a cold). . . . *The signs of some of these reactions . . . would have been missed, except for careful medical observation during challenge.*' To summarize; cows' milk sensitivity is common; it produces symptoms in about 6 per cent of infants, and the symptoms are often quite mild; but these mild symptoms are the only premonition of a potentially fatal anaphylactic reaction, which kills more children than road accidents do. The dangerous age is two weeks to six months.

What protection can goats' milk offer? At the International Dairy Goat Conference (1964)[6] Dr. Walker stated that milk allergy could be divided into (*a*) allergy to cow lacto-albumin, (*b*) allergy to all animal lacto-albumin, (*c*) allergy to casein. If that were so goats' milk would be 100 per cent effective in case (*a*) and totally ineffective in cases (*b*) and (*c*). This does not conform with the experience of many who have used goats' milk in the treatment of allergy. Dr. Walker's reference was to the authority of Dr. Frankland (1959). But in 1959 Dr. Frankland[13] was merely quoting what Dr. Hill wrote in 1939. It is more than doubtful whether Dr. Hill, a venerable American paediatrician, still holds that opinion, in the face of the parallel findings of several different investigators in different countries. The milk-allergic children, in the American study mentioned above, reacted to the different proteins of cows' milk as follows:

to casein	57%
to beta lactoglobulin	66%
to alpha lactalbumin	54%
to bovine serum albumin (= beef allergy)	51%

42% were allergic to one protein
27% were allergic to two proteins
17% were allergic to three proteins
14% were allergic to all four proteins.

All these separate proteins of cows' milk can be further subdivided into fractions which are allergically distinct. The same is true of the proteins of goats' milk. With the exception of bovine serum albumin, some of the subdivided fractions of each of the cows' milk proteins are allergically identical with some of the subdivided fractions of the corresponding goats' milk protein; other fractions are allergically distinct.[14 15] It is not thought that bovine serum albumin has a common factor with goats' serum albumin, but serum albumin in milk is rendered harmless by boiling, and only 14 per cent of milk-

4. 'The whole flock comes scampering after the delinquent leader.' It is not easy for the goatherd to slip away from the flock in open country

probably due to the difficulty in avoiding the offending foods. Allergy to cows' milk includes allergy to all foods containing cows' milk in any form; in obvious forms such as butter and cheese, and in less obvious forms such as toffee, cake mix, packet soups etc. Other recent investigations[7] have shown that at least half those allergic to cows' milk are allergic to that part of it which is found in all beef protein (bovine serum albumen); these people are therefore allergic to beef and beef extract; to gelatine, jellies, fruit gums and throat pastilles; to most canned and packeted soups, and to babyfoods fortified with bone flour. To the practical difficulty of sustaining so restricted a diet is added the psychological difficulty of practising so much self-denial, uncomforted by a cup of ordinary milky tea. Goats' milk must ease the situation for an adult, and for a child with cows' milk allergy goats' milk is almost essential.

Most cows' milk allergy originates in infancy; the great majority of bottle-fed babies become sensitized to cows' milk after a week or two on the bottle;[8] though most of them develop no very troublesome symptoms, and lose their sensitivity as their digestive secretions grow stronger, a 6 per cent minority with weaker digestive capacity become highly sensitized, and are unable to maintain normal health and growth on a cows' milk diet.[8] Among the more highly sensitized of the bottle-fed babies are to be found most of the victims of 'Sudden Death in Infancy'.[9] These are the babies that die in their sleep, or collapse and die unexpectedly without any previous sign of serious illness. Regurgitating and inhaling in his sleep some of his last bottle feed—cows' milk to which he is sensitized—brings the antigen, in massive quantities, in intimate contact with the sensitized cells of the air passages; such is thought to be the fatal process in some cases.[10] In others, merely swallowing a few ounces of cows' milk may cause anaphylactic shock.[11] A recent Ministry of Health Report suggests that cows' milk allergy may be one of the three main causes of sudden death in infancy. These sudden deaths account for at least a fifth of all infant mortality;* twice as many children die suddenly and unexpectedly in infancy, as are killed in road accidents. The other main causes of these sudden deaths, suggested by the Ministry of Health, are accidental suffocation and infection.

Full and careful reading of the Ministry report, and of the literature to which it refers, gives a true indication of the gravity of the problem of cows' milk allergy in infants. But a cursory reading of the summary conclusions may be misleading. The proportion of these deaths due

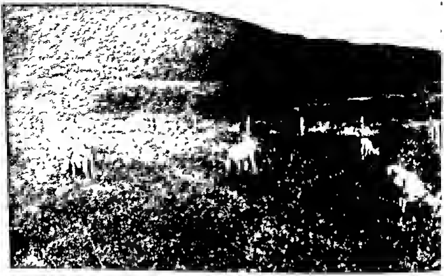
* Twenty-seven per cent in a U.S.A. army community in West Germany.

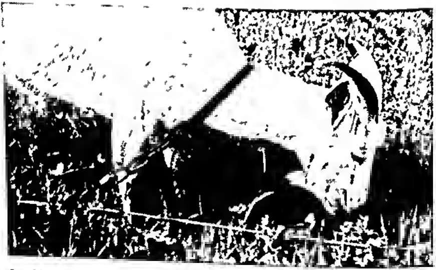
to accidental suffocation is small; the evidence gathered by the Ministry inquiry supports the conclusion of the 1945 Davison survey, published by the *British Medical Journal,* that accidental suffocation plays no part whatever in 88 per cent of sudden deaths. Nor did five years of intensive research find any direct evidence that bacterial or viral infection played a part in any significant proportion of the cases studied. The children who died were, in many cases, reported to have shown previous symptoms which were equally consistent with respiratory allergy and respiratory infection; they tended to die during the winter months when respiratory allergy and infection are most troublesome. Allergic disease increases liability to infection, and infective disease increases liability to allergic reactions; but in the course of this inquiry the children who died were shown to have had a relatively high count of antibodies to cows' milk, and 42 per cent of those examined had cows' milk in their air passages; infection may well have played a part, but it was not identifiable.

The Ministry of Health report is best understood when read in conjunction with a related American study of milk-allergic children.[11 12] Eighty-nine children were selected on the basis that their symptoms ceased completely when the cows' milk in their diet was replaced by soya-bean milk, and recurred regularly when cows' milk was reintroduced. When the milk-allergic children were 'challenged' with a measured dose of cows' milk the reactions affected the digestive system (vomiting, diarrhoea, abdominal pain) the respiratory system, (runny nose, wheezing, etc.), the skin (nettlerash, eczema, dermatitis) and the whole constitution (anaphylactic shock) in various combinations:

(*a*) 19% had digestive symptoms only
(*b*) 23% had digestive and respiratory symptoms
(*c*) 12% had digestive and skin symptoms
(*d*) 9% had respiratory symptoms only
(*e*) 10% had skin symptoms only
(*f*) 17% had skin and respiratory symptoms
(*g*) 10% had digestive, respiratory and skin symptoms.

Half the children in category (*g*) and one-fifth of the children in category (*f*) developed anaphylactic shock and nearly died. There were two other cases of anaphylactic shock, making 10 per cent of the whole sample. The research report comments: '*If the patients who exhibited anaphylactic reactions had died earlier in the course of their illness, they would have been classed as a sudden, unexpected, death. . . . The auscultatory findings in some of these patients were indistinguish-*





5 *and* 6. Some of the author's goats, normally on unrestricted free range, are here seen tethered on running tethers to clear a new lea of thistles which weed killers couldn't kill. From the hazel scrub in the background of the upper picture over one thousand pounds of cream per year were produced for sale in the southern cities

allergic children are allergic to this protein alone.[11] If the proteins of goats' milk passed through the lining of the digestive tract, unchanged and undigested, into the tissues of the body, as readily as do those of cows' milk, the value of goats' milk in the treatment of cows' milk allergy would be small. It would be useful only in the very mildest cases.

On the basis of the impressions of twenty-five years of practical experience in three different allergy clinics, a doctor has said that 99 per cent of infants who fail to thrive on cows' milk do well on goats' milk.[6] In a recent recorded survey of 300 children with asthma due to cows' milk allergy, 270 were symptom free after six weeks when goats' milk replaced cows' milk in the diet.[6] An avalanche of international testimony falls into the same pattern. On the other hand, plenty of clear-cut cases of allergy to goats' milk have been reported.[11] Knowing, as we do, that to most cows' milk allergy patients, the potential allergenicity of goats' milk is considerable, we can only conclude that in the great majority of cases the proteins of goats' milk are unable to pass through the walls of the digestive tract into the body tissues in their original, undigested, allergenic, state. In other words, goats' milk is so quickly and easily digested that the allergenic protein is seldom absorbed unchanged.

In the attempt to identify the food, drug or inhalant which is causing allergic disease, doctors often use a 'skin test', injecting or pricking into the skin a small quantity of the suspected allergen, suitably diluted. Local inflammation around the site of injection constitutes a positive reaction. The test is notoriously unreliable; negative reactions occur in patients highly sensitized to the substance tested; positive reactions occur in patients who do not produce allergic symptoms in response to the substance tested; the only significance of the positive reaction is that it proves the presence in the skin of antibodies to the substance tested.[16] In the case of cows' milk it has been found that patients allergic to foods other than milk, give more 'positive reaction' than patients who are allergic to cows' milk.[11] The patients allergic to foods other than cows' milk are merely registering the fact that they were allergic to cows' milk before they developed the capacity to digest it thoroughly and quickly. Most food-allergy patients may be expected to give a positive reaction to a goats' milk skin test, because they were allergic to cows' milk in infancy. The reaction is almost totally irrelevant.

When the food or inhalant responsible for a case of allergic disease has been identified, it is not always possible for the patient to avoid

it. One solution is to 'desensitize' him. This is achieved, in the case of food allergy, by persistently feeding the patient a quantity of the allergenic food just sufficient to produce the mildest symptoms.[17] In the less severe cases of milk allergy, changing from fresh to boiled, evaporated or dried cows' milk may achieve this effect, because the allergenicity of the milk is reduced by heat treatment.[18] In the more severe cases of milk allergy, goats' milk may perform the same function; its allergenicity is still lower than that of processed cows' milk, and less of the allergenic protein is absorbed unchanged. Under the constant mild assault, the body developes a 'blocking antibody' which does not 'home' on to a cell, but digests its antigen while freely circulating, without triggering the release of histamine.

In most cases, cows' milk allergy patients are able to digest goats' milk so much more easily and quickly that they do not absorb enough allergenic milk protein to produce any symptoms at all. In the most desperate cases, goats' milk usually has the desensitizing effect described above. But in these latter cases it sometimes happens that, after two or three weeks of satisfactory, if slow, improvement, there is a sharp relapse to severe allergic symptoms as the patient becomes newly sensitized to the specific fraction of goats' milk protein which is absent from cows' milk. This is most likely to happen if the patient catches some infection, is subject to acute anxiety, or has a digestive upset. In that case the symptoms will pass with the disturbing factor and improvement will continue. If the relapse persists, it is advisable to reduce the quantity of goats' milk intake until the symptoms subside, or to use dried goats' milk for a while.

Another sort of relapse may occur in milk-allergy patients who have experienced total relief of symptoms within ten days of changing over to goats' milk. (Skin symptoms always take longer to disappear; say four weeks.) These relapses happen a month or two or more after the change to goats' milk and are usually due to relaxation of vigilance; cream toffees, or fruit gums or milk chocolate are common culprits.

Bearing these considerations in mind, the use of goats' milk in the treatment of milk allergy in adults and older children can do no serious harm and is likely to result in dramatic or gradual improvement according to the nature of the allergy concerned. At least six months and probably a year of goats' milk diet is needed to wean a milk-allergy case back to normal diet; many can never tolerate cows' milk; it is the more acute cases that are 'desensitized' by goats' milk. It is always preferable that the patient's doctor should know what is

goiog on; in the case of adults and older children it is imperative if the patient has severe attacks of asthma, or if the eyes are affected.

Ao infant witb symptoms of cows' milk allergy is always in some daoger. If both skin and breathing are affected tbe danger must be coosidered serious. Every effort should be made to persuade tbe parents to seek the advice of tbeir doctor before chaoging tbe baby on to a goats' milk diet. Tbe condition of an infant being fed on cows' milk, io some form or other, is unlikely to deteriorate if fed tbe same amount of goats' milk, and will probably improve. A baby known to be allergic to cows' milk, being fed on a syntbetic milk, such as 'Velactin' or 'Nutrigen', or on breast milk, should be under close medical supervision wben any attempt to change over to goats' milk is to be made. Tbe new milk must be introduced gradually, starting witb minute quantities. A milk-allergic baby who bas run the gauntlet of the innumerable preparatioos of cows' milk is usually starving, and will consume prodigious quantities of goats' milk with apparent benefit if permitted to do so. To minimize tbe possibility of the child developiog a specific allergy to goats' milk, it is wise to limit tbe quantity of milk fed to thc norm for the child's age.

If tbey are able to recognize a case of milk allergy for what it is, most doctors would probably accept the dictum of tbe *British Medical Journal* (Marcb 1963) tbat 'goats' milk may relieve tbe symptoms in some infants, but may not be of sufficiently low allergenicity in others'. Outside infaocy, allergy to milk is usually associated witb allergy to some otber item in tbe diet. There is no very obvious reason to believe that goats' milk will have any effect on allergic reaction, except as a substitute for cows' milk, and doctors are understandably sceptical of wider claims. Yet there is something more than mere practical experience to support such claims.

Sioce allergic reaction is caused by the absorption of undigested proteios, it is reasonable to believe that food allergy is intimately connected with digestive efficiency. It is hard to prove tbat digestive incapacity plays a large part in food allergy, because one of the symptoms of food allergy may be disturbed digestion. But it is known tbat most bottle-fed infants develop a considerable antibody to cows' milk during the first few weeks of life, when their digestive secretions arc relatively weak, and lose their sensitivity as their digestive secretions grow stronger, after three or four months;[7] that most milk allergic infants have been found to have an abnormally weak digestive secretion for their age;[19] that milk allergy, taking the form of infantile eczema, commonly flares up when the infant is teething,

and his increased salivation is diluting his gastric secretion.[20] There is probably enough evidence to justify the common-sense conclusion that an efficient and healthy digestion is likely to minimize the absorption of undigested, allergenic, proteins.

Food-allergy patients are not necessarily cursed with a patently inefficient digestion. But they experience allergic symptoms in response to an uptake of undigested protein, so small that normal people would be unaffected by it. They are therefore responsive to very slight variation in digestive efficiency. While the addition of goats' milk to the diet of normal people would have no apparent effect on their digestion or comfort, in the diet of food-allergy patients goats' milk can, and does, tip the delicate balance beneficially and reduce the uptake of allergenic protein to 'desensitizing' or asymptomatic levels. People allergic to, say, fish or eggs can consume a normal diet with impunity if the diet is supplemented with goats' milk.

Digestive peace is indivisible. The uptake of allergenic protein depends less upon the form in which the protein appears in the diet, as upon the digestibility of the whole diet and the health of the whole digestive system. Ill-prepared and irregular meals may be mitigated by goats' milk, which has been used with conspicuous success by long-distance lorry drivers with allergic complaints.

Allergy patients are notoriously neurotic. Anxiety gnaws the pit of the stomach with gastric acid. Goats' milk buffers the excess acid, protecting the stomach lining from further damage, easing the burden of digestion. Sometimes, allergic reaction affects the digestive tract itself, producing a state of congestion throughout, and ideal conditions for the absorption of more allergenic protein; irrespective of what the specific allergens may be, restricting the diet to goats' milk alone, for a day or two, is often the quickest way to break the grip of such an attack. The small, soft and slightly laxative goats' milk curd finds its way through congested passages and submits to impaired digestive powers as few foods can.

In the pollen season, sufferers from hay fever may develop an allergy to certain foods—eggs, perhaps, will bring them out in spots, at this season, but produce no ill effect at other times.[21] Once the concentration of histamine in the blood has reached the level where unpleasant symptoms appear, the symptoms may be complicated and aggravated by allergens from sources which normally produce no symptoms at all.[16] Consequently goats' milk, by reducing still further a normally small and insignificant intake of food allergen, may seem

to alleviate the symptoms of an allergic attack known to be due primarily to an inhaled allergen, such as pollen or housedust. Allergy, too, is indivisible, and the effect of goats' milk is anti-allergic. Whatever the primary cause of a patient's allergic symptoms may be, goats' milk is always potentially beneficial. In the majority of allergy cases the primary cause is unknown and goats' milk is worth trying.

The production of goats' milk in Britain in 1965 was about $1\frac{1}{2}$ million gallons. There are at least 5 million people in the country with symptoms of food allergy, of whom about $1\frac{3}{4}$ million are not curable by dietary control, and would probably benefit from goats' milk. About 40,000 bottle-fed babies are highly sensitized to cows' milk, possibly 4,000 a year die as a consequence;[10 22] adults suffer and die of gastric ulceration in similar proportions. To satisfy these more urgent medical needs would require about fifty times as much goats' milk as is available. That fact is the main limitation on the use of goats' milk's curative properties. But dried goats' milk is available, and can be imported in substantial quantities; its use will create the conditions under which a more adequate supply of fresh milk becomes an economic possibility.

At the end of this chapter there are detailed notes on goats' milk diets for adults and infants. Here, there follows a discussion of the chemical analysis and physical properties of goats' milk, compared with the cows' milk and human milk it is used to replace; the practical virtues of goats' milk are related to laboratory tests.

The comparative composition of the milk of the goat, the cow and the human is shown in Table 2. The figures for human milk are, as far as possible, those applicable to 'mature' milk, of the third month of lactation, and as such differ somewhat from the more familiar but less significant figures applicable to the first fortnight of lactation, when the milk is rapidly changing in composition. The figures are derived from the extensive wartime surveys of Kon and Mawson,[26] unless otherwise specified. In several instances it has been necessary for purposes of comparison to change the form in which the proportions were originally expressed. Such calculations are asterisked.

The cow data, unless otherwise stated, are derived from Davies' *Chemistry of Milk* and are the average of an immense number of analyses.

The goat data are those given by Knowles,[25] based on his two-year survey of the milk of ninety-nine British herds, supplemented by the figures of an American team.[27]

TABLE 2

COMPARATIVE AVERAGE COMPOSITION PER CENT OF MILK

	Goat	*Cow*	*Human*	
Fat	3·8[10]	3 67	3·6–4·7	
Solids-not-Fat	8·68	9·02	8 90	
Lactose	4·08	4·78	6·92	
Total nitrogen × 6·38	3·33	3 42*	1·22*	
Total protein	2 90	3·23	1·10*	
Casein	2·47	2 63	0·4[4]	
Albumen and globulin	0 43	0 60	0 70[4]	
Non-protein nitrogen × 6 38	0 44	0·19	0·12*	
Total ash	0·79	0·73	0·31[5]	
Calcium (Ca O)	0·194	0·184	0 042*	
Phosphorus (P_2O_5)	0·270	0·234	0·060*	*Required*[2]
P_2O_5/Ca O	1·39	1·27	1·41*	*for Infant*
Chloride	0 154	0·105	0 06[5]	*—National*
Iron (pts. per 100,000)	0·068[6]	0·080[6]	0·1–0 2	*Research*
Copper (pts. per 100,000)	0 053[6]	0 057[6]	0 055[7]*	*Council*
				Standards
Vitamin A (i.u. per gm. fat)	39[8]	21[8]	31·9	30*
Vitamin B_1 (μgm./100 ml.)	68[9]*	45[3]*	17	45*
Riboflavin (μgm./100 ml.)	210[6]*	159[3]*	25·5	76*
Vitamin C (mgm. ascorbic acid/100 ml.)	2·0[6]	2 0	3 6	3·5*
Vitamin D (i.u. per gm. fat)	0·7[9]	0·7	0·27	10·0*
Calories per 100 ml.	70	69	68	

[2] Kon & Mawson, *Medical Research Council Special Report* 269 (1950).
[3] Knowles, *Brit. Goat Soc. Yr. Bk.* 1953, p. 62.
[4] Gunther, *British Journal of Nutrition* (1952), Vol. 6, No. 2, p. 215.
[5] Davies, *Chemistry of Milk*.
[6] Gamble, Ellis & Besley, *U.S.A. Dept. of Agriculture Technical Bulletin No.* 671 (1939).
[7] McCance & Widdowson, *Journal of Physiology*, 112, 450 (1951).
[8] Chanda & Owen, *Biochemical Journal*, 51, 3, 404 (1952).
[9] Houston, Kon & Thompson, *Journal of Dairy Research*, 11, 145 (1940).
[10] Mackenzie, *Goat Husbandry*, (1965).

Fat. Its high proportion of butter-fat gives goats' milk a greater coergy value per unit volume than cows' milk.

There is a cooiderable difference in the compositioo of the fat in the three milks. All fats are composed of glycerol combined with one or more of a wide raoge of fatty acids. The fatty acids of milk fat raoge from the small simple molecules containiog three atoms of carbon, to large complex molecules containing twenty-two atoms of carbon. Carbon in the form of carbohydrates is the prime source of food energy and the large fatty acid molecules represent food energy in its most compact and concentrated form.

In humao milk the fat is mostly in the form of fatty acids contaio-ing eighteeo to twenty-two atoms of carbon per molecule, which

closely resemble the fatty acids of human body fat.[28] Breast milk thus offers the infant digestion a selection of highly concentrated fatty acids almost precisely in the proportions required by the baby's body.

The fatty acids of cows' and goats' milk contain from three to seventeen atoms of carbon per molecule; while the baby is able to digest the smaller fatty acids of cows' and goats' milk entirely, and build them up into the large complex molecules of human fat, it is believed that it is unable to utilize a considerable proportion of the larger molecules of the alien fat. This residue is combined with calcium and excreted.[21] Human milk fat (and milk calcium) is thus most economically used.

In goats' milk fat there is a higher proportion of the simpler fatty acids, containing five to nine atoms of carbon, than in cows' milk fat.[27] As these are thought to comprise the simpler 'building bricks' most efficiently utilized by the infant digestion, the fact may have some bearing on the superior digestibility of goats' milk fat.

But the ease with which the fat of goats' milk is digested is largely explained by the size of the fat globules in goats' milk. The fat of the milk of all species is present in the form of small globules more or less evenly distributed through the body of the milk. The action of rennin in the new-born stomach curdles the casein, thus holding the fat dispersed through the curd and releasing it for digestion globule by globule. So there is no danger of this highly concentrated nutrient being presented to the digestive processes in big drops or clumps that would cause indigestion and diarrhoea.

The size of the fat globules varies in the milk of one animal, and varies with breed, with feeding and with stage of lactation. The average size of the fat globules of cows' milk ranges from 2½ to 3½ microns in diameter—the larger globules being characteristic of the Channel Islands breeds. The average size of the fat globules of goats' milk is 2 microns.[27] Put in a more meaningful way: the average globule in cows' milk contains twice to five times as much fat as the average globule in goats' milk.

The small size of fat globule possibly has a bearing on the value of goats' milk in cheese- and ice-cream-making, and accounts for some difficulties in the mechanical separation of goats' cream.

Lactose. The high percentage of lactose is typical of human milk and that of other animals, such as the horse and donkey, in which the suckling period is a small proportion of the period of growth from conception to maturity. Why all milk sugar should consist exclusively

of lactose is not known. Lactose fed to some animals assists the ahsorption of calcium and has an antirachitic effect similar to that of vitamin D; animals fed on diets in which tbe sugar content is exclusively lactose cootain less fat, more cerehrosides (hrain matter) and live longer tban animals on a sucrose diet.[31] But in spite of maoy efforts to prove lactose superior to other sugars for infant feeding, the results are inconclusive.[23]

The difference in lactose content between goats' milk and cows' milk has no great significance. The addition to goats' milk of rather less tban a level teaspoonful of sugar per pint would equalize the sugar content of the two milks. Mild diabetics on a diet of restricted carbohydrates can consume goats' milk more liberally tban cows' milk. Four ounces of goats' milk can replace 3½ ounces of cows' milk on the diahetic diet sheet.

Nitrogen. The nitrogen content of goats' and cows' milk is approximately three times that of human milk.

Many attempts have heen made to attrihute the superiority of human milk for infant feeding to the distrihution of the nitrogen in human milk, to the high proportion of albumeo and glohulin and the low proportion of casein; hut there is no indication that this feature has any nutritional significance. The three proteins, alhumen, glohulin and casein, have heen hroken down into their component amino-acids in the hope of finding some significant difference in nutritional value at this level. For some time importance was attached to tbe supposed relative poverty of cows' milk in the sulphur-containing amino-acids, cystine and methionine; but more modern research[32] bas indicated that the cystine and methionine content of human and cows' milk is of the same order. Investigation of the amino-acid content of goats' milk has so far failed to suggest that it differs in nutritional value from that of cows' or buman milk[14] hut the casein of goats' milk differs in structure from that of cows' milk.

The non-protein nitrogen fraction of milk has not been subjected to the same degree of investigation as the protein fraction: apart from some free amino-acids, the components of non-protein nitrogen have little or no value in human nutrition, and this field of investigation is not a promising one. The relatively higb proportion of non-protein nitrogen in goats' milk is possibly valuahle in assisting the development of symhiotic bacteria in the digestive tract of the kid, but is prohably almost entirely excreted unchanged hy the human consumer.

It would appear that, if the superiority of human milk for infaot feeding is associated with the nitrogen content, it is associated with the characteristic which stares the analyst in the face: the low cootent of total oitrogen and of protein nitrogen in particular.

While there are oo important differences io the composition of the proteins of cows' and goats' milk, there are highly significant differences hetweeo the physical characteristics of thc curd that these proteins form uoder the actioo of reonio—the principal enzyme secreted hy the oew-boro stomach and provided by the reonet of the cheese-maker.

Curd quality may he measured by two criteria: by the hardoess or softness of the curd, expressed as 'curd teosion', aod by thc relative size of the flakes in which thc curd forms.

Curd tension is measured with a Hill's 'Curdometer' or allied instrument. This is essentially a special curd knife attached to a delicate spring halance. The knife is drawo slowly through the curd and the reading on the halaoce indicates the resistance encountered. Curd tension readings for cows' aod goats' milk show the following averages and ranges:

	Cows' Milk[31] *gm.*	*Goats' Milk*[27] *gm.*
Average	70	36
Range	15–200	10–70

The softer the curd thc morc easily it can be digested. Cows' milk with a curd tension of 30 or below is found to be digestible, unhoiled and undiluted, hy iofants.[34] Boiling for one mioute reduces curd tension; longer boiling has littlc effect, but is often advised. In U.S.A. a special market for soft curd cows' milk for infant and iovalid feeding has been devcloped. Curd tension is o breed characteristic and Friesians havc been found to give the softest curd—8 per cent of Friesian milk having a curd tension under 30. Channel Islands breeds give the hardest curd. In Britain the only reliable supply of soft curd milk on the market is produced by goats; all cows' milk for infant feeding must be boiled, sterilized, homogenized, evaporated, condensed or dried. Goats' milk is digestible raw.

The other criterion of curd quality—the size of the curd flakes—is demonstrated by adding strong acid to milk. The curd is precipitated, the curd of goats' milk appearing as finely divided partieles which rapidly dissolve in the acid, that of cows' milk as large lumps which dissolve hut slowly. The phenomenon has been seen *in vitro* by every dairy worker doing the Gerber butter-fat test with goats' milk, and

cows' milk. It has also been observed to occur in the infant stomach.[35] As the enzymes which digest protein act on the surface of the protein aggregates, the more finely the curd is divided the more rapidly it is digested. The flocculent curd of human milk has similar advantages over the rubbery mass of cows' milk curd.

Minerals. The bone minerals calcium and phosphorus are found in richest supply in goats' milk and poorest in human milk. But infants fed on goats' or cows' milk are a great deal more liable to develop rickets and other symptoms of Ca and P deficiency than breast-fed babies. The more generous supply is less economically used.

Goats' milk has a higher ratio of phosphoric acid ($P^2 O^5$) to Lime (CaO) than cows' milk, and in this respect approximates human milk very closely. But the fact is not proved to have any practical value.

However, in the nutrition of adults and adolescents, at least in those countries where cereals and meat form a major part of the diet, the value of milk seems to lie very largely in its content of digestible calcium, and there is no reason to doubt that goats' milk is to be slightly preferred for this purpose.

The more marked superiority of goats' milk in phosphorus has a similar value for peoples living on a diet in which roots, fruits and green vegetables predominate. It also contributes to the higher buffering capacity of goats' milk, which is so valuable in the treatment of internal ulcers.

The strikingly high chloride content of goats' milk may have some bearing on its laxative properties, and accelerates the formation of curd under the action of rennin. This is of value to cheese-makers, who sometimes add chloride to cows' milk to improve curd quality, and speeds infant and invalid digestion.

The presence of trace elements in milk appears to depend upon their presence in the diet of the producer. The significance of the trace elements in human nutrition is little understood: but the poverty of both goats' and cows' milk in iron necessitates iron supplements (egg yolk, raisin *purée*, etc.) for bottle-fed babies. Iodine is needed for development of the thyroid gland in humans and animals; it is normally present in breast milk,[25] goats' milk and cows' milk[34] in adequate quantities. About 80 per cent of milk iodine is lost when milk is boiled, so the baby bottle-fed on cows' milk receives very little iodine from the milk; but without any notable inconvenience being caused thereby.

Vitamins. Knowledge of human vitamin requirement and methods of assaying the vitamin potency of foods are both changing from year to year. Table 2 indicates the relative vitamin potency of the three milks, and the standards believed necessary for human well-being, on the basis of recent reports. But some qualifications are necessary.

Vitamin A. The figures given for the vitamin potency of cows' milk and goats' milk were produced in an experiment in which cows and goats were given a diet with a limited carotene intake, which provided practically the same amount of carotene *per lb. of liveweight* to both goats and cows.[37] It is a measure of the efficiency with which cows and goats convert dietary carotene into milk vitamin A. On a diet of summer grazing, providing very much larger carotene intakes, the difference would probably be less.[27] Fed *ad lib.* on winter rations containing the same limited amount of carotene per pound the difference might be considerably greater as the goats' food capacity, per lb. liveweight, is two to three times greater than that of the cow. The conversion of carotene to milk vitamin A is a function which depends on the activity of the thyroid gland; the goat has a thyroid gland larger and more active than that of the cow, in proportion to its weight, and therefore carries out this conversion more efficiently.

From a practical point of view the figures are of little importance in infant feeding as the bottle-fed infant gets all the vitamin A he needs along with 'D' in his cod liver oil or proprietary supplement. But for the adult milk-drinker, goats' milk will provide approximately twice the vitamin A obtainable from the milk of cows on comparable feeding, at the time of year when the vitamin is most deficient in the human diet—late winter.

In goats' milk there is no carotene and therefore no yellow colour. The carotene is fully converted to vitamin A. In both human and cows' milk there is a proportion of carotene, which is greater in cows' milk. How much of this carotene is digestible by the infant is doubtful, as the thyroid activity necessary for its digestion is but very slightly developed in the infant.

Vitamin B_1, or 'aneurin', is the vitamin concerned, among other things, with nervous control: human need of the vitamin is thought to increase with the intake of sugar and other carbohydrates and there is some evidence that the vitamin plays a part in protein digestion and metabolism. There is little doubt that normal intakes of the vitamin in Britain are inadequate, except among those who eat a lot of wholemeal bread. Milk of all kinds is an important source. Goats'

milk is 50 per cent richer in the vitamin than cows' milk, and four times as rich as human milk. However, the breast-fed baby having a lower protein intake than the bottle-fed baby appears to have smaller need of the vitamin. It is possible that the vitamin B_1 content of goats' milk contributes largely to the efficacy of goats' milk in the treatment of neuro-digestive disorders and insomnia. Neither goat nor cow rely on a dietary supply of the vitamin, as it is synthesized for them by the bacteria of their digestive tract: the richness of goats' milk in this vitamin is therefore a constitutional characteristic largely independent of diet.

Riboflavin—another vitamin of the B complex—is a growth factor of which adult needs appear to be met by a normal diet and infant needs to increase with bottle feeding. Its presence in milk is largely dependent upon its presence in the diet of the producer. The figures in Table 2, which indicate the exceptional wealth of goats' milk in the vitamin, are based on a comparison of the vitamin potency of the milk of cows and goats consuming a comparable diet.

Vitamin C. Both goats and cows meet their own requirements of this vitamin by synthesizing it from the constituents of their own blood; it is doubtful if they require a dietary supply at all. The milk of both species is far too poor in the vitamin to meet the needs of the bottle-fed infant, who must receive supplements: e.g. orange juice, Infant Celin tablets, etc.

Vitamin D. Although human milk provides far less of the vitamin than is believed to be required by the infant, so that vitamin-D supplements are normally advised for breast-fed infants, the incidence of rickets in breast-fed babies not receiving a supplement is unexpectedly low. It has been suggested that this is due to the antirachitic effect of the high lactose content of breast milk, and to the transference of irradiated fats from the skin of the mother to the baby during breast feeds.[28]

Though slightly better provided than human milk with vitamin D, both goats' and cows' milk are inadequate sources of the vitamin for infants and adults. Bottle-fed infants who do not receive a vitamin-D supplement contract rickets more readily than the breast-fed baby. Artificially irradiated milk has a useful vitamin-D content, but unless rather expensive precautions are taken, it also has a peculiar flavour. It is generally more convenient and economical to provide vitamin-D supplements than to 'vitaminize' the milk.

Vitamin E is not mentioned in Table 2. Human requirements of the vitamin are unknown, but it is widely advertised as the 'fertility

vitamin'—on the curious assumption that human needs are identical with those of the albino rat. With almost equal justice it might be advertised as the 'muscle vitamin' on the strength of the fact that a deficiency in calves, kids and lambs results in muscular dystrophy. (Some of the human infertility cures attributed to the vitamin E of wheat meal might be more safely credited to the beneficial effects on the nervous system of wheat meal's B_1.) Goats are reported to transfer a dietary supply of the vitamin into their milk more readily than cows; this would have a significance in human nutrition if humans were shown to need the vitamin. In the meantime, it is an argument for using goats' milk for calf rearing under certain conditions.

Enzymes. The presence in milk of enzymes appears to be an accidental consequence of the working arrangements of the mammary gland, rather than a positive contribution to the nutritive properties of the milk.

The function of an enzyme is to decompose its specific sub-stratae. The enzymes of milk are not functional in normal sterile samples, and the amount of enzymes present in milk parallels the amount present in the blood of the producer, reaching its highest level when the producer is diseased.

From the limited amount of work which has been done on the enzymes of goats' milk, the outstanding feature is the absence from goats' milk of two enzymes present in cows' milk and human milk—amylase and catalase aldehyde; and the relatively small amount of phosphotase found in goats' milk.[3]

The milk enzymes are not believed to provide any nutrient, nor is their presence thought to aid the digestion of milk. The nutritional significance of the lower enzyme content of goats' milk, if any, might be to enhance its keeping qualities.

Acidity and buffering effect. Both cows' and goats' milk are slightly acid in reaction, both milks giving a normal pH range of 6·4 to 6·7.[21, 23] Human milk is normally neutral. All milk becomes more acid in reaction when it has been kept, due to the development of lactic acid out of lactose by bacteria.

Like all body fluids, milk contains 'buffers', the effect of which is to prevent changes in the reaction (or pH value) of the fluid, living organisms being highly sensitive to such changes. Consequently, milk can 'absorb' a quantity of acid or alkali, without changing its reaction proportionately.

This characteristic of milk makes it valuable in the treatment of peptic ulcers, wben constant irritation by tbe action of digestive juices is damaging the lining of the digestive tract. For tbe same reason milk is used in the treatment of poisoning by alkali or acid.

On the other band, a highly buffered fluid is not ideal for infant feeding, because the infant's capacity for secreting acid is limited and tbe food solution must be given an acid reaction (about pH5) before it can be digested.

The principal buffer components of milk are tbe proteins and tbe pbosphates. Though goats' milk bas a lower protein content than cows' milk of average composition, it has a higher buffering effect,[27] due presumably to tbe higher proportion and different arrangement of the phospbates in goats' milk. As would be expected from its composition, buman milk bas a low buffer effect.[33]

Thus undiluted goats' milk is superior to cows' milk for its buffer valne in tbe treatment of gastric ulcer. But as dilution lowers the buffer value, and goats' milk can stand a high level of dilution and still meet the infant's needs in Calorie content, its higb buffer value need not diminisb the value of goats' milk for infant feeding.

VARIATIONS IN THE COMPOSITION OF GOATS' MILK

This commentary on tbe nutritive properties of goats' milk bas been based upon milk of average composition. An average is not necessarily a representative sample, and may be no more tban the mid-point between extremes of common occurrence. Of tbe samples used in the two-year survey of Knowles and Watkins, about two-thirds contained 3 to 5 per cent of butter-fat, and between 8 and 9 per cent of solids-not-fat. The averages given for these major components of goats' milk accord well with those fonnd in a less extensive but more recent survey.[31]

These figures founded on the milk of high-yielding goats in Britain seem to be broadly applicable to tbe high-yielding goats of the rest of Europe. The Swiss breed societies (with the exception of the Toggenburg) were commonly reporting breed averages of over 4 per cent butter-fat in 1949. The Spanish Milk Control Board (1942) credits tbe Murcian goat with a breed average of 4·6 per cent butter-fat.[40] The other high-yielding Spanish breeds (Granada and Costenga) are said to yield over 4 per cent butter-fat in their milk[41]—4·64 per cent butter-fat is recorded for the milk of a typical high-yielding German

Hartz goat, in Denmark.[42] Such consistency is not altogether surprising as French, German, Swiss, Scandinavian and British goats of high-milking strains are derived to a great extent from a common stock. For the past two hundred years Spanish goat-breeding, under the wing of the ancient 'Sheep masters' Guild', has been justifiably self-sufficient. But during the hey-day of the Spanish Empire, Spain probably drew extensively on the excellence of the goat stock of northern Europe. Until the 1920s goats figured prominently in the small farmyards that sizeable ocean-going vessels took to sea, to provide fresh food on the voyage, so all high-yielding strains of goats tend to have a cosmopolitan background. The goats of Canada, U.S.A., Australia and New Zealand are mostly derived from stock imported from Britain, northern Europe and Spain, and the average composition of goats' milk in these countries can be assumed to accord with the figures given.

But throughout Britain, northern Europe and the New World there are two breeds of goats whose milk diverges markedly from the average in composition. The Swiss Toggenburg has been exported in large numbers: in its native country the breed averages 3·3 per cent butter-fat,[43] and in the Knowles & Watkins survey in Britain Toggenburg milk averaged 3·8 per cent butter-fat; from U.S.A. an average of 3·7 per cent is reported. The low butter-fat percentage is also apparent in Toggenburg crosses, to judge by the percentage of British Toggenburgs disqualified in milking competitions for low butter-fat. On the basis of Royal Dairy Show records it would appear that the low butter-fat is associated with low solids-not-fat, though the solids-not-fat deviate only slightly from normal. This impression accords with Crepin's figure—2·7 per cent protein. Toggenburg milk does not therefore lend itself to dilution for low protein infant-feeding mixtures as well as goats' milk of normal composition. Early analyses of the milk of Swiss goats often gave very much lower figures. These may be accepted with some reserve. Where butter-fat testing is done by centrifuging the milk, the standard time and speed of centrifuging required to separate and measure the fat content of cows' milk will not separate all the fat of goats' milk, owing to the slowness with which the small globules of goats' milk fat move in response to centrifugal force. Strict adherence to BSS for the Gerber test gives accurate results with goats' milk—considerably lower standards give accurate results with cows' milk. This fact has not always been understood by analysts.

Goats of Oriental origin have found their way to Britain, Spain and

France in significant numbers, and have left their mark on the goat stock of these countries. They and their progeny have been re-exported to the New World. In U.S.A. these goats have exercised a big influence on the general stock. The milk of these goats, of which the Egyptian Zariby is the finest example, is characterized by a high butter-fat percentage and a high percentage of solids-not-fat. The average butter-fat percentage of Anglo-Nubian goats' milk in the Knowles-Watkins survey was 5·6 per cent (4·8 per cent in the author's 1965 survey). Crepin[44] records 6·3 per cent butter-fat for the pure Zariby. Solids-not-fat are commonly between 9 and 10 per cent. This milk has all the nutritional advantages of goats' milk of average composition, and is generally considered exceptionally palatable; the curd may be a little harder than normal and the buffering effect is higher. For infant feeding a higher level of dilution is desirable; the necessary adjustments are indicated in the table at the end of this chapter.

The composition and properties of goats' milk vary with stage of lactation. Even when an infant is being fed on the milk of one goat (bulked milk is usually preferable) this variation is unlikely to have any practical significance except at one stage. The fall in yield and rise in fat and solids-not-fat percentages towards the end of lactation frequently occur rather sharply—a week or ten days of rapid change followed by a more gradual tendency. In feeding infants, allowance must be made for the rise in protein and fat percentage and an increase in curd tension during the sudden fall in milk yield in the later stages of lactation, otherwise vomiting of the excess causes unnecessary trouble to mother and baby.

Variation in the composition of the milk of the various breeds of goats has been considered only in relationship to the milk of the high-yielding breeds. Probably the majority of the world's goats'-milk drinkers consume the produce of goats yielding under 3 pints a day. At this level of production it is probable that diet has more influence on milk composition than breed. As Lusk[45] remarks, the composition of goats' milk varies more widely than that of cows' milk because the goat, even the lower-yielding goat, produces more milk in proportion to bodyweight than the cow, and more readily reflects differences in diet in milk composition. The underfed goat produces milk rich in butter-fat and poor in solids-not-fat; the overfed goat, and especially the goat with a high-fluid intake, produces milk poor in butter-fat and great in quantity.

GOATS' MILK DIETS

Infant Feeding. In designing the recipes for infant feeding with goats' milk the aim has been to provide a 'humanized' mixture in the early stages. Twenty years ago, such low-protein mixtures were still in fashion; ten years ago they were taboo; now the pendulum is swinging back again; with the publication of the M.O.H. report on 'Sudden Death in Infancy' the pendulum must swing back faster. The effect of high-protein feeding of young farm livestock is discussed in the appropriate chapter; there is no reason to think that the effect on young humans is very different; but as man's body takes twenty years to mature, a spot too much protein in the baby's bottle can have little effect on his adult physique. It might have more effect on his brain, which is 70 per cent of full size at two years old and full grown at seven. The average bottle-fed baby, after making due allowance for his greater weight, takes ten days longer to reach the mental milestone of learning to walk, than if he were breast fed. But perhaps the braking effect on mental development does not persist.

Goats' milk is scarce and relatively expensive; its use in infant feeding should be concentrated on reducing the damage and danger caused by milk allergy, that is, by the absorption of undigested milk proteins. There is no sense in presenting milk proteins to the infant in any higher concentration than that needed for adequate nourishment. Fortunately goats' milk 'humanizes' relatively well; if you dilute cows' milk to bring the protein content to human milk level, the mixture is too weak to sustain normal growth unless fortified with added sugar and fat to an indigestible extent. Goats' milk is richer in fat, and poorer in protein; the 'humanized' mixture needs no added fat.

These considerations will not impress the great majority of doctors, who will doubtless continue to recommend feeding the infant as strong a mixture in as large a quantity as is happily absorbed. If that is the way you want it, goats' milk is digestible neat and raw, pasteurized or boiled, by the youngest of normal infants, or can be used to replace cows' milk in any standard infant-feeding recipe.

Infants suffering from eczema, or from digestive or respiratory symptoms of allergy to cows' milk usually need goats' milk until they are two years old; they often lose their symptoms at the normal weaning age, but have periodic relapses when teething. If the allergic symptoms are severe it will be necessary to follow the restricted diet

recommended for adults (see below), and particularly to avoid processed baby foods containing derivatives of cows' milk and beef. In eczema caused by milk allergy the use of antihistamine or steroid ointments over long periods does more harm than good; while such treatment is being carried out goats' milk can do little good, and it is undesirable that goats' milk should be associated with the ill effects. Other ointments used for eczema cases contain animal fat with traces of allergenic protein. To give goats' milk a fair chance of effecting a cure, it should be used with no other 'ointment' than Olive Oil, B.P.

If a baby has to be bottle fed from birth, there is no known means of replacing the protective immunity to common infections which it would naturally obtain from breast milk. But goats' milk is useful in preventing the build up of sensitivity to milk protein which normally takes place during the first few weeks of life, when the baby's digestive secretions are inadequate to denature the proteins of cows' milk before they are absorbed. The sensitivity is dangerous. It is known that infants digest goats' milk more quickly, easily and thoroughly than they digest cows' milk; but it is not known whether the baby, bottle fed on goats' milk from birth, becomes sensitized to goats' milk protein or not. Probably not, but it is safer to assume the contrary and act accordingly.

Where possible, the infant who is to be bottle fed from birth should start on goats' milk, and stick to it for six or eight weeks, by which time his digestion should be better able to cope with the tougher cows' milk curd. Any sensitivity to goats' milk protein acquired during the first weeks of life, is unlikely to be seriously challenged by the small amount of cows' milk protein which evades his more mature digestive powers.

An infant bottle fed from birth on cows' milk takes two or three weeks to become sensitized to the milk. At any time between two weeks and four months, he would be better protected from the dangers of milk allergy if changed over to goats' milk. At four to six months of age, most normal babies can digest cows' milk effectively and lose their sensitivity to it; after this stage is reached there is no specific advantage in a goats' milk diet for normal children.

An infant bottle fed on cows' milk, showing symptoms of milk allergy, eczema, chronic 'snuffles' or wheezing, or chronic digestive trouble, may well be in serious danger. A change to goats' milk is an urgent safety measure, which should be maintained until the baby is about two years old. All changes from one milk to another should be

carried out cautiously; the first feed of the new milk being very dilute. This is most important in changing a baby back from goats' milk to cows' milk, if he has previously proved intolerant of cows' milk. The doctor should be consulted about any such change.

Adult Diets. Prescribed for the treatment of gastric ulcer, dyspepsia, insomnia, liver disease, etc., goats' milk produces predictable results. Used to treat food allergy, the results, though often dramatic, are less regular and less certain. The patient or parent should understand that anyone suffering from food allergy, after the age of weaning, is likely to be sensitive to more than one food; that the role of goats' milk is to replace cows' milk (the commonest allergen) and improve the efficiency of digestion, so that potential allergens are denatured before they are absorbed through the wall of the digestive tract into the blood-stream. An immediate and dramatic cure is only possible if cows' milk is the only allergen involved, which, in adults, is unusual. Normally, the patient can expect an improvement in condition at first, large or small according to the importance of cows' milk in his normal diet, followed by a slow cure spread over anything up to six months, punctuated by a few sharp relapses, due to digestive stress or large intakes of allergenic food.

A quicker cure and a smoother passage to normal health can be achieved if allergens other than cows' milk are eliminated from the diet. Allergy patients become sensitized to the proteins prevalent in their diet; so that, though it is quite possible by means of a wide statistical survey to identify the allergens that give most trouble to most people, such a list is not of great use in correcting the diet of any one person. The prohibition of porridge and lentils has been found necessary for several cases in the north of Scotland, but one doubts its relevance for an allergic tycoon in Denham, Bucks. Lobster is taboo for allergic patients who can afford it, and quite harmless to those who cannot. The principle is that the staple foods in the diet of the allergic patient must be changed. There are only two specific prohibitions which apply to most patients—against cows' milk products and against beef products. Almost all food-allergy patients are sensitive to cows' milk and half those sensitive to cows' milk are sensitive to beef as well. Milk and beef permeate our diet in so many different forms that one or other or both are staple food for almost everyone. In the table below common allergens are listed, roughly in order of prevalence, along with some of the forms in which they occur and some alternative foods. For some people the 'alternative food'

(1)	(2)		(3)	(4)	(5)	24-Hour Milk Mixture using Average Goats' Milk (4·0% butter fat)		
Age	*Average Weight*		*Total Calories Required*	*Average Maximum Daily Fluid Intake*	*Calories Required from Milk*	*Milk*	*Lactose or Sugar Level tablespoons*	*Water*
	lb.	*oz.*		*oz.*		*oz.*		*oz.*
14 days	7	0	320	23	252	12	2 (L)	11
1 month	8	4	380	25	305	14	2½ (L)	11
2 months	9	12	440	30	350	17	2½ (L)	13
3 months	11	8	500	32½	403	19	3 (L)	13½
4 months	13	0	560	35	452	21	2½ (S)	14
5 months	14	4	620†	40	500†	25	3 (S)	15
6 months	15	4	680†	40	560†	28	3 (S)	12
7 months	16	4	740†	40	620†	31	3 (S)	9
8 months	17	4	800†	35	680	31	2½ (S)	4
9 months	18	4	860†	35	740	33	2 (S)	2
10 months	19	4	920†	30	680	30	1 (S)	—
11 months	20	0	980†	30	680	30	1 (S)	—
12 months	21	0	1010†	30	680	30	1 (S)	—

† Additional energy is expended in exercise: 60 calories per day are estimated to meet this need in calculating recipes.
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INFANT FEEDING TABLE 2—ADJUSTING RECIPES TO MILK OF VARIOUS COMPOSITION

Percentage of Butter Fat	2·5	3·0	3·5	4·0	4·5	5·0	5·5	6·0	6·5	7·0	7·5	8·0
Calories per oz.	16	18	19½	21	23	24½	26	27½	29	31	32½	34

To calculate the recipe for a milk of any given butter fat, divide 'Calories Required from Milk' (Column 5 in Table 1) for the appropriate age or weight, by Calories per oz. (Table 2) to obtain the ounces of milk required in the 24-hour mixture. The amount of lactose or sugar required is 1 level tablespoon of lactose or ¾ level tablespoon of sugar for each 10 oz. of Daily Fluid Intake (Column 4, Table 1), for any age up to 9 months; thereafter the amount of sugar is reduced in accordance with the amount of sugar and starch in the solid feeding. Water is added to bring the quantity of mixture up to the figure given in Column 4.

Supplements: (1) Orange juice should be introduced at 4–5 weeks old, starting with a half teaspoonful.
(2) Adexolin or Radiostollum should be introduced at 14 days old, starting at 1 drop per bottle. A change may be made to codliver oil if this is well tolerated at any time after 6 weeks old.
(3) Marmite (1 teaspoon in the day's mix) should be introduced at 3 weeks old.
(4) Fresh raw egg yolk may be introduced at 3–4 months, starting with 1 teaspoonful per day.

may be the allergen, and the food listed as an nllergen may be quite innocent. The difficulties of the situation underlinc the importancc to the allergic patient of nursing the efficiency of his digcstive system, so as to minimize tbe absorption of such allergens as may be present. Good cooking, regular meals, moderation of thirst and appetite, can, along with a pint or two of goats' milk, cover the inevitable errors of diet.

Allergen	*Also in the form of . . .*	*Alternative foods*
Cows' milk	Butter, cheese, tinned and packet soups, cake-mix, toffee, milk chocolate	Goats' milk, 'Vclactin', margarine, Norwegian whey cheese, goat-milk cheese
Beef	Meat extract, meat loaf, sausage, tinned meat, tinned nnd packet soup, chicken stock cubes, gelatine, table jellies, fruit gums, tinned baby foods, fortified baby cereals (bone flour)	Mutton, poultry, game, venison, horse, yeast extract
Wheat	Flour, bread, cakes, biscuits, tinned and packeted soups, meat loaf, sausage, breakfast cereals	Cornflour, riceflour, oatmeal, rye crispbread, oatcake, cornflakes, rice crispies, potatoes, root vegetables
Fish		
Eggs		
Lentils		Peas, beans, bean curd
Tomatoes		Most other fresb fruit
Bananas		
Oranges		
Chocolate	Cocoa	

N.B. Ointments prescribed for tbe treatment of eczema and psoriasis may contain derivatives of beef or cows' milk. Exclude tbe possibility before using tbem, or use olive oil instead.

Injections. Anti-histamine, adrenalin and steroid injections are useful to control an emergency, but to food-allergy patients tbey are likely to do more barm than good, if used over long periods. A patient receiving them will benefit little from goats' milk, and the reputation of goats' milk will benefit not at all from the association.

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Chapter 4

THE PROSPECTS FOR GOAT FARMING

The recent scientific work on the prevalence and danger of cows' milk allergy was first reported in the medical press in 1960, and achieved mention in a Ministry of Health Report only in 1965. There has, so far, been neither time nor inclination to put the new knowledge to use. But, in the absence of an adequate alternative to cows' milk, doctors can use the new knowledge only to underline a pious advocacy of breast feeding and to foretell the tragedies they cannot prevent. The need for an alternative to normal cows' milk will be generally admitted before long, but we will not find the Ministry of Health prescribing goats' milk until it is readily obtainable in the necessary quality and quantity.

The potential market for an 'alternative' milk in Britain is substantial—about $1\frac{1}{2}$ million gallons per annum for infant feeding and up to 50 million gallons for adult treatment. Competitors are already on the field, warming up. There is a synthetic milk substitute based on vegetable protein, and a preparation of cows' milk from which most of the lacto-albumen (the main allergen) has been removed. Though neither is as safe, pleasant and generally effective as goats' milk, they already have a bigger share of the small alternative milk market that exists, because they are advertised in medical publications and reliable as to quality and availability. Both need further proving or modification before they can fully satisfy the requirements of an 'alternative milk'; but they will certainly receive the financial support their potential deserves. Unless a reliable supply of dried goats' milk is marketed and advertised with comparable expertise within the next two or three years, goats' milk will be out of the running, and we shall be saddled with a second-best alternative milk.

Putting dried goats' milk on the market is a straightforward business proposition which should prove attractive to any of the big baby-food companies who stand to lose some of their normal cows' milk market, anyway. Dried goats' milk has been launched on the

baby-food market before, under less auspicious circumstances. The project sank, not because demand was insufficient, but because the goats' milk producers failed to maintain adequate supplies. So long as the goat is seen as a maverick, the people who breed goats tend to be mavericks too; so do the people who write about them. It is high time that the goat was made an honest dairy beast, attended by stockmen, owned by farmers (or baby-food companies) and written about by B.Sc., Ph.D. authors, like all other respectable farm stock. Too many lives depend upon goats' milk for us to entrust its production to mavericks.

Dried milk is the necessary basis for a hold on the infant-feeding market, where any product which is going to fill the need for an 'alternative' milk must earn its respectability and its reputation as a trouble-shooter. In the treatment of digestive and allergic symptoms in older children and adults there are so many dietary factors involved that it is difficult to assess the value of the milk used very conclusively. Although dried milk is a clinical product, which no one over the age of twelve months consumes with much pleasure; although fresh milk is preferable for older children and adults; although goats' milk is the only conceivable fresh alternative to cows' milk; goats' milk will be recommended by doctors for treatment of digestive and allergic complaints in the higher age groups only if they have proved its efficacy in the baby's bottle. The baby-food market is the key to the very much larger market for an alternative fresh milk.

Dried-milk production is best organized on large, specialized, farms, owned by or under contract to, the marketing company. The seasonal nature of goats' milk production is no embarrassment in this situation, since the drying capacity not used for goats' milk can be used temporarily for cows' milk.

In supplying the medical need for fresh goats' milk, the problem is that the potential customers, who need the milk, comprise not much more than 6 per cent of the population, are widely scattered through the community, hard to contact, difficult to cover in adequate number with a milk-round of manageable extent. To be effective the supply of goats' milk must be completely reliable; breakdown in delivery can endanger the customer's health. These problems are most easily overcome in a densely populated area, where the ideal solution lies in the hands of a small farmer running a holding of ten to twenty acres, specializing in goats, with a stock of 50 to 100 milkers. He will be in contact with the allergy clinics of local hospitals and will distribute the milk through a local retail dairy company, who will treat the

goats' milk like any other premium milk, delivering to most of the customers and retainiog a refrigerated buffer stock at their main shops aod depots for customers who cannot he covered hy the delivery round.

It is hetter that this market be supplied by a goats' milk specialist, because it calls for someooe who is committed to fulfilling the responsihilities involved. The temptation to take on, io summer, more customers thao cao be supplied io the wioter, has to be resisted; the allergy clinics aod G.P.s prescribiog goats' milk have to he kept in touch with the supply positioo. There must be a working arraogement with the Medical Officer of Health aod the Health aod Welfare Committee of the local authority, to agree prices, to arrange quality cootrol, to ensure that goats' milk customers henefit from the Welfare Food Seheme like other citizens, aod receive special assistance to pay for the more expensive milk if oecessary.

In the early stages it may be oecessary to carry out much publicity work. The previous chapter summarizes the facts ahout goats' milk in a way that medical men can check or accept. The difficulty is to get them to look at the facts at all. Amoog the geoeral public there is always a small minority allergic to cows' milk, but there is also an overwhelming majority, which includes most of the potential goats' milk customers, who are allergic to any sort of serious scientific argument. Products are not sold hy their merits hut hy their 'images'. Creating an 'image' for goats' milk requires a certain amount of fanaticism or cynicism, preferably a little of hoth. Much good has been done to those who oeed goats' milk and to those who produce it, by enthusiasts making quite outrageously exaggerated statements ahout the value of goats' milk io letters to the press and oo every availahle social occasion. Arouse interest, curiosity, even indignation, and the hattle is won. We have the facts and we have goats' milk and can rely on hoth to make a good impression. Calm a conscience queasy ahout such advertising with the thought that we are selling a highly beneficial food in competition with purveyors of alcoholism, drug addictioo and lung cancer.

The customers of of Health Food Shops, and of the Health Food Counters of hig stores, are usually the first fish to be hooked hy lurid advertisement of goats' milk. Though most of the regular goats' milk customers will eventually be those with real medical need, the Health Food enthusiasts are a providential receptacle for the summer milk surplus of the goat dairying specialist. Regular customers must have an all-year-round supply; goats' milk pro-

duction being inevitably much lower in winter, there is always a surplus in summer. To a small extent this may be used to build up a store of deep-frozen milk for winter use, but most of it can be sold to the Health Food Shops in the form of genuine, live, goats' milk yoghourt, which is prepared by an exact, but not at all laborious or expensive, process. You cannot sell this really delicious article through the multiple dairies, because it would make a mockery of the often insipid product which they make themselves and sell as 'yoghourt'.

In less densely populated areas it becomes increasingly difficult to find enough goats' milk customers within reach of a daily milk round to provide the dairy goat specialist with a reasonable living. Co-operation with medical authorities, and delivery through the retail dairy network, are harder to arrange. Publicity and advertising demand the expenditure of more effort and receive a smaller response. Somewhere along the road from the city to the mountains the need for fresh goats' milk must be met by part-timers—either by domestic goat-keepers selling a constant surplus, or by a goat-dairying sideline on a mixed farm.

The producer-retailer of cows' milk is ideally situated to run a goat-dairying sideline; he already has the dairy equipment and the means of delivery and publicity available. A regular proportion of his cows' milk customers will be suffering from indigestion, insomnia, unhappy bottle-fed babies, or other such distress that goats' milk can allay. They will accept *his* advice to buy goats' milk; they will be glad to pay a little extra for the relief it brings; the farmer will be glad not to have to pay a levy to the Milk Marketing Board on his goats' milk sales.

Many producer retailers do a line in cream. Goats' cream offers pleasant surprises to producer and consumer. Being richer in butter-fat, on the average, a gallon of goats' milk yields more cream; goats' cream being of lower specific gravity, a given weight takes up more space; a gallon of goats' milk yields cream to fill 20 per cent more cream cartons than a gallon of cows' milk. The housewife will find that the goats' cream whips to greater bulk, 'goes further', and does not give grandpa indigestion.

The problem of the summer surplus of goats' milk on a mixed farm disappears profitably down the throats of piglets, calves and fattening chickens, releasing more cows' milk for sale. Calves, especially Jerseys and Guernseys, do better on goats' milk than on the milk of their mothers; they tend to scour less frequently. One

prominent goat-breeder used to rear the most promising heifer calves for a leading breeder and exhibitor of pedigree Red Polls.

The cow and goat dairy farmer must resist the temptation to mix the milks. A trace of cows' milk in a goats' milk diet can wreck havoc on an allergic patient. The addition of goats' milk to a bottle of cows' milk diminishes the depth of the cream line on which milk quality is commonly judged. The fat of goats' milk is so finely divided that it takes several days to rise and form a cream line.

Much of the goats' milk available in the countryside must come from the regular surplus of domestic goat-keepers, and the show flocks of goat-fanciers. The economic pros and cons are not the decisive factor in domestic goat-keeping. It is more a matter of social values, of the accepted 'way of life'. Goat-keeping is often a symbol of a deeply felt minority faith. Between those who work overtime in an uncongenial occupation to buy labour-saving domestic gadgetry and manufactured pleasures, and those who cut the cost of living by the (to them) congenial labour of goat-keeping, gardening, and doing-it-yourself, there is fixed a great gulf. From whichever side you view it, Hell is on the other. Those on the goat-keepers' side are an increasing minority.

In the rural areas it is often impossible for the doctor to prescribe goats' milk without prescribing domestic goat-keeping to produce it. As household providers goats can perform their function under an extremely wide range of conditions—the world milk record was broken by a goat fed largely on greengrocer's waste in a Bermondsey back street in the middle of the 'V' Bomb Blitz. The retail dairy's costs and profits are increasing very much more rapidly than those of the milk producer, so that the economic advantages of home production are steadily improving. Compulsory pasteurization has depressed the palatability of available cows' milk, so home-produced goats' milk not only saves 4½d. per pint but tastes better too. If that is what the doctor orders . . . who can say no?

At times it may happen that the cost of goats' milk production is not a very serious consideration; when dairy produce is scarce or money plentiful the special qualities of goats' milk can always secure a market for a regular and clean supply, with little regard to price. But the market for agricultural produce sees bad times as well as good. If goat dairying is to enjoy any useful degree of stability, and any resistance to adverse economic conditions, it must be founded on a supply of cheap fodder.

Probably the ideal site for goat farming is a block of cut-over

woodland within marketing range of a fair-sized town. The second growth should be at least two years old and preferably in that stage when thistles, nettles and docks are hurtling weed seeds into the surrounding fields from behind a barricade of brambles and saplings. Stocked at the rate of one goat to the acre such ground will sustain yields of 6 to 10 pints a head from leaf-bud to leaf-fall, and winter yields of 2 to 3 pints a head with little or no supplementary feeding of bulk foods. During the winter the goats will be living mainly on tree bark and brushwood; if the stocking is any heavier than one goat to the acre the cumulative deterioration of the woody growth will ruin the goat grazing in about ten years. But if the goats are hand-fed with roughages during the winter the summer stocking capacity can easily be raised to two or three goats per acre, depending on the size of the goats.

The nature of the sapling growth is also important. Elm, ash, hazel, willow, hawthorn and sycamore are the best for summer grazing; elm, willow, ash, holly and ivy are the most valuable in winter; oak is of limited value; so is alder and birch; beech is virtually useless. Of the shrubs, briars are most valuable in summer, brambles in early spring and winter, gorse and broom in late winter and spring; heather is first-rate feeding from autumn to mid-winter, and blaeberry (whortleberry) during spring and summer.

Mature woodland also makes good goat grazing, if of suitable type. Softwoods are valueless, but a stocking of one goat to three or four acres is suitable for mixed hardwoods; though goats will put paid to natural regeneration they will not do substantial damage to mature trees. Once the leaves have fallen and started to rot mature woodland will not feed goats through the winter unless it has some of the winter feeding shrubs mentioned above.

In view of the afforestation programme it is perhaps narrow-minded to look at cut-over woodland simply as a source of goat milk. Foresters would rather regard it as future planting ground—but as such they cannot but view it over the top of a more or less insurmountable obstacle. The capital and labour required to kill the second growth is great, and the supply of both is scarce. Goats will kill it by barking the saplings in the winter and fire will clear what they kill. One-hundred-acre blocks will support an economic goat dairy unit for a man and a half; over larger blocks systematic destruction would be more difficult to organize, and the control of the goats might cause trouble. Fencing off an extensive area of cut-over woodland into 100-acre blocks might prove expensive, and the

goats would take perhaps ten years tn achieve their purpose; but schemes more expensive of land and money are known tn forestry.

As a sore in the eye of tbe travelling farmer few sigbts can compare with that of tbe hostile arsenal of weed and vermin in a cut-over wood. But occasionally he passes a comparable menace in worked-out clay pits and open-cast irnn mines. Here, too, the goat can control, suppress and convert tn milk the troubles of the general farmer. Moreover, the amount of fencing required on such sites is relatively small; though able to negotiate anything whicb is not quite smooth and vertical the goat is retained by a sheer rise of nnly 5 feet, and by a sheer drop of 10 tn 15 feet. The London Brick Company probably owns as much potentially prnfitable goat grazing as any landowner in Britain.

In coastal and hill districts many a farm has a considerable waste acreage occupied with cliffs and rocks and n vegetation consisting mainly of brambles and briars and a certain amount of dangerously situated grass. This is useful goat grazing, however inhospitable tbe rock may appear, but it will not support sn many goats as beavy scrub.

Under domestie or commercial farming conditions, goats will do exceedingly well fed on borticultural wastes. Not only will tbey consume and casb tbe very wide variety of garden wastes, from fruit tree and shrub prunings to docks and nettles, but will provide a good supply of manure of a kind highly suitable for gardening purposes, being light to handle, warm and quiek acting and almost entirely free of weed seeds even witbout being cnmposted; goat dung made during the summer has a higher nitrogen content tban borse dung, cow dung or sheep dung; weight for weight, it has more than three times the value of FYM. As an adjunct to horticulture, yarded goats can often be fitted into the existing organization of the holding with a positive saving of labour and materials. Whether the milk is marketed at a good price for human consumption nr used for stock rearing on the holding is not then of prime consequence.

The stock returns for horticultural holdings frequently include a few pigs. For piglet feeding the high digestibility of the fat and protein of goats' milk and its superinrity in mineral and vitamin content give it the same kind nf advantage nver cows' milk that it has in infant feeding. Pigs and goats always make a happy combination which avoids marketing difficulties for goat dairy produce if required, hut can also accompany a sideline in goats' cream, which can be sold to compete in price with cows' cream.

It is an attractive thonght tn employ the goat, who can utilize the

rougher fodders with such unique economy, to make milk of moorland and hill pastures. But the notion is only occasionally practicable. Apart from the difficulties of marketing goat dairy produce from remote areas, the herbage of hill grazings and moorland is often unsuitable for goats. Where the soil coverage of the hill is predominantly free-draining peat, and the vegetation consists mainly of heather and other ericaceous plants such as blaeberry (wbortleberry), it will sustain moderate yields of 4 to 6 pints per head, and good bealth. Heather is good winter feed, is rich in lime and bas a respectable content of protein; but it must be burnt regularly to keep it productive. Blaeberry is first-rate summer feeding for tbe goat, being mineral rich with a good protein content, but it does not flourish among heatber which is regularly burnt. Hill pastures including substantial acreages of blaeberry as well as well-burnt heatber are relatively rare, and are the only ones really suitable for commercial goat dairying—and tben only if they are witbin reach of a market.

The hill grasses sucb as white bent and molinia are minerally deficient; the goat bas small appetite for them and is liable to mineral deficiency diseases on such a diet; moreover, these grasses grow mainly on sodden ground, which goats instinctively dislike, and whicb harbours a wealth of parasitic worm larvae peculiarly dangerous to the goat.

Nevertheless, as an adjunct to a hill sheep farm a few goats will usually pay their way. The hard-earned hay from marginal meadows pays poor dividends if fed to a house cow which is dry for two or three months of the year. The same hay will sustain two or three goats with an all-year-round yield of greater volume. On a hill sheep farm a few goats can usually find a sufficient variety of shrubs, trees and weeds to sustain their summer yields, without destroying what shelter facilities the limited woodland provides.

Goats' milk is very much better digested by the lamb than cows' milk; it can be fed undiluted and fresh from the earliest stages. Fed to blackface ram lambs goats' milk ensures the production of classic horn growth; cows' milk produces too close and light a growth, while the milk of a well-fed ewe of good milking capacity produces a growth which is too wide and heavy for fashionable taste.

Goats will often prove useful in keeping sheep out of daagerous cliffs in the early spring, by clearing the rock ledges of green temptation before any other beast can get near them. On very high and extensive cliffs the cure will not be complete as the sheep are inclined to follow the goat tracks down the cliff, and cannot follow them up

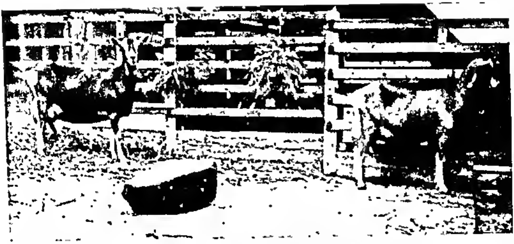
again. But provided the cliffs are sufficiently restricted in extent and vegetation to enable a reasonable number of goats to control the growth on them in early spring, the cure is completely effective.

Goats are also extremely useful to the sheep farmer seriously troubled with brambles. If tethered, preferably on a running tether during early summer, goats will graze the brambles to extinction. The job is not suitable for a well-bred dairy goat, who will become half-starved in the process; but a rough scrub goat will do the job effectively with little discomfort to herself. Goats of a milkier type can still play a substantial role in bramble clearance, as they will happily graze to destruction any brambles on their range which have been scythed in the previous winter; they will not tackle an untended bramble thicket on their own, though they may stop it spreading.

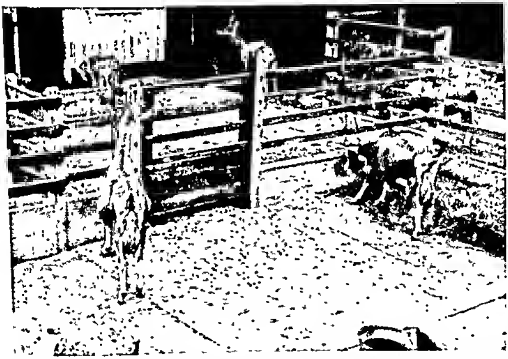
Any hill farmer who has expended time and energy on bracken clearance will be familiar with the distressing phenomenon that a heavy growth of brackens, once controlled, is usually succeeded by a fine crop of nettles and thistles and docks, which not only limit the grazing value but tear the wool of the sheep. This is a nuisance which will not survive a year of goat grazing, but tends to get worse under sheep and cattle grazing.

The hill farmer does not usually look for a dairy round as a source of income; but the house cow has often helped the economy of the holding by producing a surplus which is taken up by neighbours whose cow is dry, and by summer visitors. With the price emphasis and subsidy on beef cattle, this surplus is rapidly becoming a distant memory in hill districts. Dairy vans and milk churns are travelling hundreds of miles each day from arable districts into the hill country; the milk they carry is normally 'on its last legs' by the time it reaches its destination in July; summer visitors do not take well to drinking sour milk in the country. A small goat dairy herd will find ready business in the neighbourhood of many a remote holiday village, and will pay its way on the hill farm which specializes in summer visitors. People will form an illogically rosy memory of the beauties of the holiday resort where they were relieved of the minor digestive distresses that goats' milk so efficiently allays.

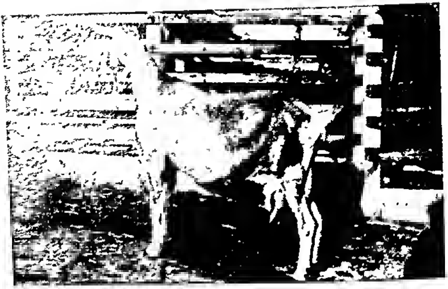
Goats have occupied a minute corner in general agricultural practice for many years. It is worth recording that they are still entitled to it. Science has not yet put paid to the unlikely belief that a goat run with a herd of cows will prevent or reduce the incidence of abortion. Sympathy is certainly due to the veterinary surgeon who complains that it is bad enough dealing with a byre full of aborting cows,



7. Twin milkers of the Hanchurch herd after 5 years in the yards; the lump of rock in the foreground keeps hooves trimmed more efficiently and less laboriously than a paring knife would do. It should feature in every loose box or yard where goats are kept under intensive conditions



8. Goats of the Hanchurch herd in their exercise yards, in which they spend their whole life. An unbroken record of good health and high yields recommends this novel solution to the problem of goat control and management. The substantial construction, with pre-cast concrete posts and wooden rails, is a measure of the confidence felt in these methods by Mrs. Oldacre, Staffs., who pioneered them. It replaced a flimsier structure after a nine-year trial period



9. AR 3 Bashley Penn BTR 437 after twelve years in the yards in which she produced over 22,000 lb. of milk

10. Inside the Malpas Goat House where the modern dairy goat has acquired several of her valuable qualities, one is impressed with the orderliness and careful detail that lie behind the successes bred there A commercial dairy farmer would prefer fewer shelves on which coliform bacteria could accumulate in dung dust

without having the smell of hilly goat to add insult to injury. Goats have no effect on contagious ahortion of cattle. But the presence of a few goats with the herd is the hest protection available to many farmers against the danger of the cows ahorting as a result of ergot poisoning.

Ergot is a fungus which grows on the flower and seed heads of cereals and some grasses, especially ryegrass. Perhaps because the flower and seed heads are richer in minerals than the rest of the plant, perhaps because they are less liable to harbour parasitic worm larvae, a goat grazing grass shows a marked preference for this portion of the plant. In a field of flowering ryegrass they will eat nothing but the flower heads, ergot-stricken or not. Goats do suffer from ergot poisoning if they eat sufficient; hut cows ahort on a small dosage of the poison and the goat's grazing hahits give substantial protection to the cows at slight risk to the goat. Billy goats are preferred for the purpose for obvious reasons.

Goats have a comparahle corner in the stahle; hut here sex is immaterial and the purpose is different. There is an immense amount of empirical evidence, hut no scientific explanation, for the belief that the presence of goats in a stable prevents the disease known as 'staggers'. Such a notion is as scientific as any until it has been scientifically disproved; whether it is acceptable to the scientific horseman or not, the goat earns its place in his stahle as an insurance against fire damage.

Horses naturally rely on the speed of flight to escape from enemies and perils; the goat's safety lies in strategic retreat to inaccessihility. Panic, which lends wings to the horse's flight, is foreign to the calculated retreat of the goat. On several occasions during the war the truth of the old tradition was demonstrated afresh. The goat's calmness in the presence of fire and high explosive enabled it to lead horses, otherwise unmanageably panic-stricken, to safety.

Goats are used extensively in Austria, Italy and Spain to consume the organic wastes of several industries—including the important olive oil and tomato-canning concerns. These countries are not so burdened with legislation affecting the disposal of wastes and the subsidiary goat enterprises are run at a profit. In this country it might well prove more economic to feed wastes to goats at a considerable loss, rather than to dry and burn them in compliance with regulations. Edible wastes of low fibre content already have a capacious dumping ground in the national pig trough. It is the high fibre wastes of the canning industry and the fruit syrup factories which appear to provide

the most suitable goat food. To the enterprising management advice from the agricultural advisory service and the British Goat Society is free; 'goat girls' are available and they cost less tban engineers. But in the trial stage it would he unwise to trust too implicitly to continental experience—the type of goat used on the Continent for this purpose is, for tbe most part, the small goat of *Capra prisca* ancestry whicb seems to be able to thrive on a more concentrated ration than our *Capra aegagrus* derivatives. On the Continent labour eosts are of less account and a system of individual stall feeding is adopted; here a yarding system, as described in Chapter 5, would appear more economic in labour and is certainly healthier for the goat.

Chapter 5

THE CONTROL OF GOATS

Much popular prejudice against goats and many real problems of goat farming arise out of the special difficulty involved in keeping goats under control. In cultivated areas the goat's contempt for the normal stock fences and their destructiveness to trees, gardens and crops is notorious; on waste land—mountain, heath and cliff—the tendency of the goat to return to the wild (turn feral) is a significant nuisance. Even when narrowly confined to a yard or loose box, the goat contrives to trespass on the privacy and liberty of her owner by refusing to thrive or be silent out of her owner's company. For all these sins the penalty and solution may be found in the collar and tethering chain—the most laborious method of controlling farm stock, and one to which the goat is naturally ill adjusted.

It must be admitted that the goat is inherently less easy to control than other members of the farmyard community; yet the nature of the goat is disciplined, co-operative and intelligent; most of the difficulty in controlling her arises out of the fact that the goat's psychology, her requirements in the way of food and shelter, and the specifications for the fence that will control her, are so very different from those of other farm stock.

Psychologically, the goat has some particularly striking peculiarities. It is almost impossible to drive goats; they do not share with the other grazing beasts the convenient habit of packing and turning their tail to the approach of danger, dogs and omnipotent man; nor do they share with cattle and horses the instinct to put as much distance as time will permit between themselves and an object of suspicion. Goats scatter and face the enemy that comes suddenly upon them, committing their safety, not to speed and distance, but to superior agility and manœuvre. The pursuit of a frightened cow or horse follows a bee-line, which can be directed by outflanking; the pursuit of a goat follows the course that the ragged rascal ran—round and round the rugged rock.

It is certainly possible to perform the illusion of driving a flock of goats, but only when there is a personal and private arrangement between the goatherd and the flock. In reality the flock is being led from behind, as the king billy of the wild flock may often lead; if the goatherd who is 'driving' the flock turns about and goes home, so does the flock.

The unfortunate Mary was able to call the cattle home across the sands of Dee, so long as her call meant relief to the cow with a distended udder or food to the cow with an empty belly. To cows with full bellies and empty udders Mary calls in vain, and has to send the dog to fetch them. But a goatherd can call his flock of hungry goats away from their foraging, and they will follow him, complaining but obedient, to be shut up in a cold yard for the night.

Yet should Mary let her cattle roam the sands of Dee with their suckled calves from year's end to year's end, and never set eye on them, she and the dog can still drive them home when required with little more trouble than usual. Let goats roam unattended and unrestricted with their suckling kids for a few weeks, and, if you see them again, they will be wild creatures; there is a slim chance that if you follow the flock slowly and call to them in familiar tones they may eventually respond; but as for using a dog on them, you are as well advised to send him after the red deer.

The psychological relationship between man and his domesticated animals, horses, cows, sheep, dogs, and poultry, is specialized. The behaviour of these animals towards man is different from their behaviour towards any other creature and different from the behaviour towards man of their wild counterparts in captivity. The relationship is the product of centuries of selective breeding and may be said to constitute their domestication. In this sense goats are not domesticated. At times they treat man as they treat members of their own species, at other times they treat man as their wild ancestors do in a natural state. There is no qualitative difference between the behaviour towards man of wild goats captured young and that of so-called domesticated goats.

Anyone who has the care of goats soon grows to realize that the relationship between the goatherd and his flock is a great deal more personal, more intimate and more delicate than is usual in the farmyard. It is in fact similar to the relationship with a gregarious animal that has been tamed from the wild. But those who tame and control wild animals usually have an advantage that goatherds often lack—a good knowledge of the social behaviour of the animal they are tam-

ing. It is a great deal easier to control goats if you understand something of the social structure and routine of the wild flock on which the behaviour of domesticated goats is based.

The wild goat flock consists of up to thirty or forty goats of all ages and both sexes. In structure it is an easy-going patriarchy. The king billy of the flock rules by right of strength and courage; be maintains discipline, keeps tbe peace and coberence of the flock and is its constant guardian. He leads the single file in peaceful movement, but shares the practical leadersbip of the foraging expedition witb an old she-goat, the flock queen, who will normally outlast a succession of kings. Billies are expendable; their great size, ever-growing horn and hair and extravagant sexual habits tbrow a constant strain on them; tbeir fearless readiness in defence of tbe flock secures for them an early and heroic end when available. Yet the billy is utterly egocentric; the flock is for him an extension of his own person; his care for the flock is but arrogance, and the flock but render him his due. They accord obedience while he is present; but they do not lament his absence. It is the old she-goat, the flock queen, who is the mainspring of the life of the flock.

When she stops to feed, the flock feeds, when she raises her head from browsing and stares at the billy, the king moves on to the next foraging site. In the face of danger she leads the flock to safety while the billy brings up the rear and holds tbe enemy at bay. She sounds the alarm if any member of the flock is missing, and will not be content until he is found. Wben sbe is absent the flock is in turmoil. If tbe flock grows too large for its range it is an old she-goat that leads the breakaway party, with a young billy as guardian, to form a new flock.

The flock is coherent throughout the greater part of the year. Most of the kids are born within the space of a few days and at this time the goats in kid break away from the flock for ahout a week, the king billy keeping the remnant togetber till the flock re-forms. For some weeks thereafter the flock queen is too much occupied with maternal duties to take much part in flock leadership, which rests almost entirely on the shoulders of the hilly; at this season, when his protection is most needed, he enjoys more power than at any other.

About a month before the onset of the breeding season the king billy is much occupied in chastising his sons and grandsons, the motbcrs cease to call their kids and the flock travels long distances on to poorer grazings in a very straggly formation. Only at nightfall does the flock rc-form during this period; it re-forms where its

wanderings find it, and does not return to its citadel for the night as it does at other seasons. This late summer wandering serves to wean the kids and alter the flock's diet from the soft milk-producing forage of summer to the hard heat-producing forage of winter.

When man enters the social circle of the goat flock he (or she) assumes the rank of kid, flock queen or king billy, according to circumstance. As kid, man can milk the flock peaceably; as king billy or flock queen, man can lead the flock. If the goatherd has nothing to do but milk and lead his flock he will have no more difficulty in controlling his goats than the little boys, of seven to twelve years of age, who keep their flocks from trespassing in the surrounding fenceless fields all the way from Lisbon to Pekin. There is no great difficulty in getting into the social circle of the goat's confidence; the difficulty arises in getting in and out at your convenience and still exercising control.

Many goat-keepers start with the indiscretion of weaning their kids on to a feeding-bottle at birth and keeping them separate from their emotional mothers until the fount of maternal milk and affection has dried up. The mothers so treated expend part of their energies properly devoted to making milk, in calling for their human kid-substitute, and devise whatever means and mischief their ingenuity can contrive to bring their kid-substitute hurtling out of the house to chase and handle them. It is more peaceful and profitable to allow kids that are to be kept to suckle their mother for the first four or five days, then wean the kids on to the bottle, but leave them in small kid-boxes, beside their mother in the goat-shed, where they can be seen and smelt and heard, but not suckled, for a further ten days. Thereafter they can run with their mother without fear of their sucking her. Kids make good progress if allowed to suck their mothers on range. Contrary to popular opinion kids so reared are more manageable when adult than kids reared away from the mother; emotional deprivation in youth does not make for emotional stability in adult life in man or beast; the goat has a deeper fund of patience, time and topical knowledge with which to educate and discipline her own kid, than any human mother-substitute.

The policy of allowing the natural social organization of the goat flock scope to develop is, in general, a sound one. The flock of intensively kept goats devotes itself more wholly and happily to milk production if it is allowed a modicum of communal life; yarding goats is preferable to stall-feeding for this reason among others. (Always assuming that the yarded goats are all dehorned or hornless.) Unless

the goats have opportunity to give a practical demonstration of their strength, agility and character *to one another*, they lack the data on which to appoint a flock queen. If there is no flock queen in the flock her human attendant becomes for each member of the flock an indispensable companion in whose absence she feels insecure and ill-content. As goats are highly intelligent they soon learn that the more noisy, destructive, wasteful and faddy with their food they are, the longer they enjoy the desired company.

To keep one goat alone, unless you are prepared to spend most of your life with her, is not only troublesome but extremely cruel.

If the goat is permitted to love its own kid and the flock to embody their sense of security in one of their own number, it becomes possible for the goatherd to enter and withdraw from the flock without disturbing the even tenor of its way. The goatherd then fills the role of kid only briefly at milking times, and for the most part occupies the position of king billy in the social structure of the flock.

Even so, withdrawal from the flock is not always easy. It is easy for the goatherd to leave the goat-shed or field and shut the door or gate; provided he leaves kids and a flock queen behind him, he does not leave a bleating vacuum. It is less easy for the goatherd to lead the flock out on range and to leave them there.

The king billy leads his flock in peaceful movement, with the flock queen close behind or beside him. Both know the rounds of their range in detail; according to wind and weather and season they follow a predestined course. King billy stops at an ash thicket; the flock queen starts stripping the young leaves; the rest of the flock follow suit; though other palatable forage be close at hand, ash leaves is the table d'hôte for all. King billy reaches highest and eats ravenously; flock queen bends down the branches for the smaller fry, but doesn't forget her own needs. After about ten minutes the flock queen stops eating, approaches king billy, who is still stuffing himself, stares at him pointedly and, if necessary, makes a small remark. King billy stops eating and moves on. The rest of the flock who have scattered through the thicket, hurry to re-form the single file and follow. Next stop is for a patch of scrub oak (to balance laxative ash) where the same procedure is repeated. After perhaps a dozen stops and starts the flock settles for the day on a suitable area of mixed browsing and there each one eats to repletion, lies down to cud and eats again. Towards evening king billy leads the flock back to their 'citadel' or goat-shed by stages. Occasionally the flock queen or another senior member of the flock may stop for a moment to

satisfy some personal requirement—say conifer bark—king billy waiting politely or holding on his way according to the importance of the goat who has stopped, but the rest of the flock do not feed.

The goatherd who knows bis flock and range can lead on the first stage or two of their wanderings and as soon as they are all busy at a popular stop he can quietly slip away. The flock queen will call him when she is ready to move on, but if he has disappeared she will take the lead herself. This tactic works well in broken wooded country; but in open country the delinquent leader is caught in the act of escape and the whole flock comes scampering after him.

Under such conditions the goatherd must use plain language to tell his flock when he has ceased tn be their king billy. Mere rudeness won't suffice; king billy's manners are not of the best; a push and a grunt and a show of displeasure convey his warning to the flock to obey and follow him more closely. But king billy doesn't throw sticks or stones; the performance of such an act is a special characteristic of man and monkey which is peculiarly repulsive to all other species. So long as it is carried out calmly and ceremonially, so as not to be mistaken for mere rudeness, the flock will turn their backs on the goatherd, will go their way and leave him to go his. The popular use of effeminate males has produced flocks of half-witted goats which may be incapable of finding amongst themselves a flock queen of sufficient independence of cbaracter to accept even so broad a hint as the thrown stick. If sucb a flock refuses to be content without a king billy to lead them, the only cure is to give them a real one.

But the introduction of a male goat into tbe flock on range brings into close perspective a problem that is inherent in the relationship between the flock and the goatherd. Because the only way of controlling the flock is to be accepted as a member of it, the goatherd's position is always open to the same challenge as that which faces the flock queen and the king billy. Occasionally the flock queen may challenge his right to lead; an adult male with the flock nn free range will always make the attempt at least once. Honeyed words and bribery are wasted nn a rebellinus goat. A good sound trouncing is needed; not just an angry slap, but a stand-up fight and a walloping thorough defeat.

As a prefect at school I was told tn inquire into the circumstances wherehy a certain small boy, nf peculiarly retiring character, came to get his Sunday-hest suit covered with Inng white hairs and peculiar odour each Sabbath day. I fnllnwed the small boy when he took the liberty of a Sunday afternnnn walk by himself. He led me several

miles across country to a small paddock in which there was tethered a very large white billy goat with awesome horns and ferocious habits. The billy must have weighed twice as much as the small boy who approached him purposefully. Having taunted the billy to the end of his tether the boy grabbed him simultaneously by one ear and the tail, drew the two extremities together, forcing the billy to stagger round in a circle, downed him, rubbed his nose in the dirt, and then let him go. Then he did it all again. Satisfied, he returned to school and his retiring habits.

For the treatment of repression in small boys better techniques may have been developed—but in seventeen years of goat husbandry I have been unable to discover a technique for the treatment of rebellious goats which is as effective, nor one which calls for less strength in the operator, nor one which is less painful for the goat. The need for some such treatment is widely acknowledged; for lack of a humane and practical one resource is had to hunting crops and other inhumane and impractical measures.

Not that the male goat is normally obstreperous—on the contrary, a vicious billy is a rarity and his ill nature due either to being tethered and teased by small boys and small dogs, or to being closely confined and handled with fear and distaste by attendants unable to control him.

In the wild flock the king billy is one of the most tolerant patriarchs of the animal world; he puts up with immature and adult males, personally instructs the youngsters in good manners and flock defence and only hunts them off during the height of the breeding season—and then with more formality than effect. Young males happily accept the lead of the king billy and are equally prepared to accept the goatherd as his substitute. But an adult male, though normally amenable, will if run with a flock on free range, challenge the goatherd's lead at two seasons of the year.

During the period which follows the birth of the kids, when the flock queen is occupied with maternal responsibilities and the billy's defensive potentialities enhance his importance in the eyes of the flock, an assertive male will often try to take control out of the goatherd's hands and to turn the flock feral. But the call of the milking pail has so urgent an appeal to the freshened goats, that, though the goatherd may have to go and fetch the flock for milking, there is little fear of losing control when he finds them.

But in the month before the onset of the breeding season there occurs an unfortunate community of purpose between the self-

assertive male and the milker who is trying to wean the milking-pail. In wild country there is a very serious danger of the flock turning feral, whether the billy runs with the flock or not; the danger is greater if he is with the flock.

At both of these seasons in the free-range flock the use of a dog will ease the goatherd's task. But the role of the goatherd's dog is very different from that of the shepherd's. Cattle and sheep run from both the herdsman and his dog; they are directed by manœuvring the two menaces. The goats cannot be directed by the dog; but the presence of the dog is a menace; if the goatherd calls his flock when the dog is on the other side of them they will run to their protector, the goatherd. If the menace is too close or real the goats will not respond to the goatherd's call, but will scatter and face and dodge the dog. If the billy is running with the flock he will wait and face the dog and will intervene between the dog and the flock. In the spring this doesn't matter as the milkers will respond to the goatherd's call and the billy will follow them in due course. In the autumn two dogs may be necessary, one to occupy the billy's attention, the other to turn the flock queen who may lead the flock away from the milking-pail.

The type of dogs required are working sheep-dogs. These are found in three broad categories: (1) the trial-bred 'wearer', advertised as showing 'eye and style', costing about £20 when trained; (2) the 'upstanding wearer', showing little 'eye', costing about £15 trained; (3) the noisy 'bunter', costing about £7 trained.

The trial-bred dog, with 'eye and style', is *bred* to run round his quarry and gather them together into a tight bunch, to run silent and to move his quarry by manœuvre and fixing them with his eye. He is *trained* to keep the sheep between himself and his master and so to bring them to his master. This kind of dog can be the best and the cleverest for work with goats, because they seldom apply too pressing a menace and can be controlled with great delicacy. But many of this type crouch down and rely overmuch on the power of their eye, a tactic which impresses goats more with amused interest than with alarm. Provided the dog is willing to adopt more forceful tactics of bark and bounce if his 'eye' is treated with contempt, and so convince the goats that he can be a real menace when required, the goats soon come to respect the more polite instruction. But if the dog will not lower himself to more forceful tactics he is quite useless for herding goats.

The upstanding wearer is so called because he doesn't crouch and rely on eye; like the trial-bred dog, he is bred to run round his

quarry and gather tbem into a tight bunch, and trained to keep the quarry between his master and himself; but he does not always run silent and uses the tactics of bounce and bark to sbift his quarry. This type of dog stands up better to the intervening billy and is the most reliable all-round dog for the goatberd.

The hunter runs *at* his quarry, can sometimes be trained to approach from one flank or the other, but his *raison d'etre* is to hunt them away. He is very useful for engaging the billy while a wearer heads off the rest of tbe flock, and if of the type that will approach from the flank (do a 'half-turn') and also in good command, he can provide adequate means of control on any but the wilder ranges.

No dog should be allowed to grip the goats, though jumping up and jabbing with closed mouth is innocent and effective. Trained dogs should be bought only if guaranteed free of grip. But if the goatherd loses his temper with his flock, so will the dog, however well trained.

Dogs that have been trained for work with sheep and cattle are always somewhat puzzled by the behaviour of goats when they are called upon to work them. Some dogs decide to treat tbe goats as cattle for whom a nip on the heel or the nose is often considered permissible. But the goat's heel is a great deal too near her udder for this treatment, which is in any case too pressing to be effective.

Once the goats are on the move towards the goatherd the dog must be stopped, and not allowed to hurry or chase them. The goat bas very sound physiological cause for refusing to place reliance on its speed to escape danger. Not but that a goat can put up a remarkable speed over a short distance if so inclined. A normal ten-stone goat carries about fifty pounds of fermenting herbage in her stomachs; merely from the point of view of weight such a cargo is comparable to that carried by a ewe in an advanced state of pregnancy with twin lambs; but it is probable that the heat produced by such a massive fermentation is a still greater disincentive to violent exertion. Apart from the danger to the goats, the dog that hustles them overmuch defeats his master's purpose, forcing the goats to scatter and dodge rather than run faster.

The tactical situation produced by the use of the dog should be an orderly retreat to the goatherd away from a distant menace—and not a *blitzkrieg* to command obedience. If n dog has been regularly and properly employed with the flock it should be possible, in emergency, to bring in a reluctant flock merely by giving orders to an imaginary dog. But whenever the goatherd has reason to fear that it may be

difficult to establish control of the flock on range, he should approach from above and oot from below: goats, like deer, expect their enemies to appear below them and security to lie above them.

All kinds of dog can be used with some success io herding goats if the dogs are trained and obedient. Any puppy that is reared in association with a flock of goats is likely to become ao asset to the flock. The goat flock is one of the least exclusive of social units, quite happy to adopt aoy other social creature from mao to goose. A dog so adopted will protect the flock, find lost goats, play with the kids and even turn feral along with the flock—hut he will oot control the flock. If the dog is required to cootrol it must he the goatherd's dog and oot the goats' dog. If you want to keep a dog for yourself, don't let it associate with gnats when off duty.

The control of goats is mainly a matter of preventing them trespassing, and in wilder districts preventing them turning feral. The control the goatherd can establish is effective so long as the goatherd is present, and, in so far as he can inculcate a routine it is effective when he is not present. For a free range herd the ideal is to establish a series of circular tours, each appropriate to a particular season and weather, and none of them making direct contact with forbidden ground. The initial training takes much herding time, hut once the circular tours are established, the flock will not place a hoof outside its territory unless the goatherd leads.

For nine years we herded up to thirty-two goats on free range over a thousand acres; some 300 yards from the goat-sheds a colourful garden lay unprotected and easy of access under their eyes each day. Only once was it raided—by a 'oew bny' in the flock; it just happened to be nff their beat. So did a patch nf brambles which were a death-trap to sheep—a month of regular herding was needed before the goats would include it io their self-conducted tours. On the other hand, a wartime gnat-keeper in Kent kept his gnats in a large paddock separated from his gardeo by a thoroughly goat-proof fence. During a daylight air-raid a plane drnpped a stick nf bombs across the holding: nne in the gardeo and annther on the fence between garden and paddock; while the whine of the departing plane was still in his ears the owner poked his bead nut nf his shelter tn see what had become nf the gnats grazing in the paddock. They were eating cabbages in the gardeo. The garden was oo their beat—despite the fence.

The minor problem of preventing gnats frnm poisoning themselves only arises when the basic principles of gnat control are ignnred.

Discrimination in matters of diet is a dim instioct in goats; education on the suhject is a main feature of their social life. If the social life is stunted, hy lack of communal activity and separation of mother and kid, not only are the members of the flock particularly liahle to poisoning, hut they have a jittery approach to all food, wholesome or not.

Safety from poisoning in the natural flock is achieved hy the discipline of the foraging expedition, which demands that every goat eats the same kind of herhage, in the same patch and at the same time as the leader of the flock. Though most of the older goats may liberalize this discipline to some extent it provides a constant fount of instruction as to what may he eaten and where and when. In a flock with an active communal life, it is amusing to test out reactions to unfamiliar food, hy leaving some unfamiliar hut acceptahle article, such as red cabhage, in their way. You will he rewarded hy a grand display of ham acting.

The first goat to spot an unfamiliar food, stops as if shot, snorts, and adopts the tense stance with feet set wide aod ears pricked, exactly like a red deer hind who has caught a whiff of stalker. Then comes a cautious inquisitive approach, nose stretched forward aod the hody hunched for lightning retreat. Theo the flock queen takes over the investigation, adopting the same poses, and the rest of the flock huddle and watch. First the flock queen noses the ohject; then she nihhles a hit and spits it out; nibhles agaio, and chews tentatively; if good, she swallows it, aod, as if revelation had suddenly come upon her, proceeds to wolf it. The other memhers of the flock, after a cautious sniff of identification, follow her example; each secures a morsel at least. If the mysterious food is not good, the flock queen spits it out with vehemence, snorts, fusses, runs frantically ahout wiping her mouth on the grass and pawing at it, and generally puts on a superh act of frightened disgust; tben, having done justice to her station, she reverts to her normal foraging with sudden equanimity. Each memher of the flock goes through the pantomime—the hilly snickering his protective concern. When the others bave finished their pantomime tbe billy engages the offending berb in heroic comhat and may take half an bour in obliterating its presence: a memorahle performance which must imbue the flock with a great sense of digestive security.

The only aid the goatherd can lend to the natural discrimination of the flock is himself to draw attention to, spurn and destroy any poisonous weed which evades the notice of the foraging flock.

Goats generally have good road sense: a little on the panicky side. Here, their reluctance to run directly away from an approaching menace is serviceable; they leap to the bank or the road fence and never run on in front of a car as sheep and cattle will. But a youngster may miscalculate the speed of approaching vehicles and try to cross the road to join companions on the other side. So all the goats should be kept to the one side of the road; if tethered on the roadside, the length of the tether should not permit them to reach the roadway. As goats grazing roadsides are not bona fide road users (travelling from one place to another) they have no legal right there, and there is no redress for accidents, in law.

If these comments on the psychological aspects of goat control have been mainly negative—in the sense of preventing the goats doing damage to themselves or others—it is because the positive job of maintaining a contented and productive flock is very much the same for goats as for other stock. Regular peaceful routine is, perhaps, even more necessary to the naturally disciplined goat than to their more anarchic farmyard companions.

The normal routine, which the goatherd aims to inculcate, is for the goats to forage purposefully and peaceably from their feeding racks, fields or free range, to cud in comfort and to come to the milking willingly and without excitement. If they keep out of mischief in the process, so much the better.

However idyllic the relationship between the goatherd and his flock, this pattern is liable to rupture if the goats are physically uncomfortable. The commonest form of discomfort is occasioned by the weather.

Here we come upon a curious anomaly. Goats are notorious for their objection to wind and rain, and for the haste with which they rush to shelter from the least inclemency; and goats are famed for their hardy endurance of the windiest and wettest rigours of our climate on the mountains and cliffs of the Atlantic coast. The feral goats of the mountain-tops are but a generation or two removed from the hot-house pets of the goat house. Many a winter I have seen our milk-recorded herd of British Saanens grazing a ridge in the face of a bitter north-east sleet shower which has driven the thick-coated hill cattle to shelter, and sent even the mountain sheep to a warm bed in the heather.

If the goatherd wants to evoke from his flock the hardiness which is inherent in all goats, first he must consider the profound difference between the central heating systems of goats and men. Man derives

his heat almost entirely from the oxidization, 'burning', of the carbohydrate reserves of his own body. In cold weather he eats foods rich in digestible carbohydrates (in the fuel to bank his fires), and he insulates himself in warm clothes and houses. The main source of heat for the ruminant is that produced by the bacterial fermentation of fibre in the rumen. The fuel which supplies most of the heat has not been digested by the animal; indeed, it is material that no animal can digest. So the ruminant meets the challenge of cold weather by eating yet more indigestible roughages and so lowering its intake of digestible carbohydrates.

The central heating system of all ruminants is the same in principle, but the goat carries the principle to its extreme. The goat, which can in a day eat twice to three times as much as a sheep of the same size, is naturally designed to exploit pastures too poor to support the sheep; to live on them the goat has to eat up to capacity. Consequently it is the fate of the goat to carry about with it for ever a radiant heater with two or three times the heat output of that of the sheep and to carry that sweltering load both winter and summer. Mercifully she has a thin skin and only a light covering of hair in summer, which is reinforced by the growth of underfluff in winter. Even so, you may examine the necessary generosity of her sweat ducts in the grain of morocco leather.

Being designed along lines which should provide a constant surplus of heat, the goat is sensitive to chills. The temperature at which her digestive processes work best is a relatively high one, and cold conditions of the rumen favour the activity of agents of disease.

Under domesticated conditions, especially when put out to graze good-quality pastures, the goat is often offered a diet so poor in fibre that is her main source of heat, that her rumen temperature is dangerously low and even a summer shower may chill her perilously. She comes into her shed in the evening so puffed up with cold mush that, unless her udder be laid on an insulated floor, she gets chilled again. To protect her from these risks her owner builds a fine cosy shed, which warms up quickly when the goat comes in with a little autumn roughage in her. When she goes out the following morning, with nothing but a cold, wet pudding of concentrates and mashed turnips in her, she feels the cold the more intensely. The nice cosy shed will also ensure that the underfluff in the goat's winter coat never develops fully (some scrupulous goat-keepers have been known to comb it out too); so the winds of winter strike on her bare skin. When a really cold spell arrives, the goatherd puts a suet pudding on

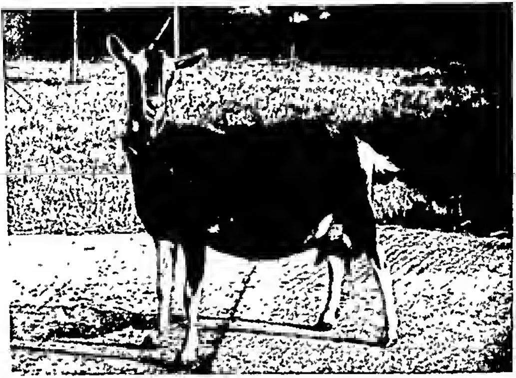
the stove for herself and an extra pound of maize in the goat's feeding hucket; so tbe goat eats even less roughage than usual and ungratefully—but logically—dies of pneumonia.

If it is desired to feed goats a highly concentrated diet, as it well may be where land and lahour are scarce, then the goats must he of a suitahle type, tbe bousing must he consistently warm and the goats must not be expected to supplement their diet by foraging outside in any hut the mildest weather.

When goats are expected to ohtain a good proportion of their food by foraging for themselves, it is essential that tbeir sbelter never hecomes beated much ahove the temperature of the outside air. In cold weatber, especially, it is bad practice to feed eoncentrates or succulents (roots, kale, etc.) unless the goat has an adequate quantity of fibre inside her. The state of affairs cannot always be tested by eye, as tbe goat may hulge with kids, gas or water; hut it can always be tested hy pressing with one's knuekles in the left flank: where fibre feels 'puddingy', kids are ahsent, gas exerts eounter-pressure and water slosbes. In summertime an alternative to highly nutritious grass should he provided in the form of hay, if nothing fresh and natural is available in the way of roughage. This will improve the goat's appetite for grass and enahle her to graze in eooler and wetter weather.

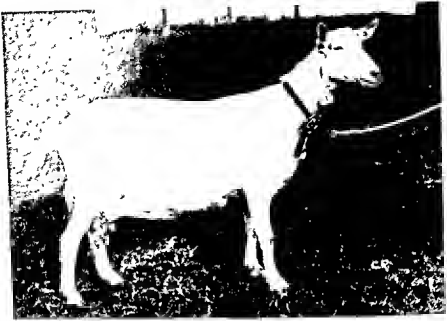
In winter, dry goats require very little in the way of nutrients and can get all they need in an hour or two on heather and a little longer on hrushwood, tree bark and hrambles; tbere is no point in keeping them out of their shelter when tbey want to return to it. But they are excellent weatber prophets and will always make tbe most of a spell of good weather if free to come and go as they want.

Wheo goats have to be supervised the wbole time they are grazing it is most irritating if tbey refuse to get on with the job, and alternate between short spells of foraging and loog spells of cudding. If tbe goats are led back to their shed as soon as they start cudding, they will sooo learn to take as much as tbey can bold io one whack, and so save herding time. Though food consumption under this arrangement is increased, the goats do not make such good use of the food they eat, eitber in tbe field or for several hours thereafter. The goat's digestion works best when relatively small quantities of fodder are passing rather rapidly through the rumen; the more nutritious the herbage the greater the losses if fed in big feeds. It is tberefore better to herd the goats out for half an hour in the morning and half an bour io the evening than to herd them for two hours on end. This is

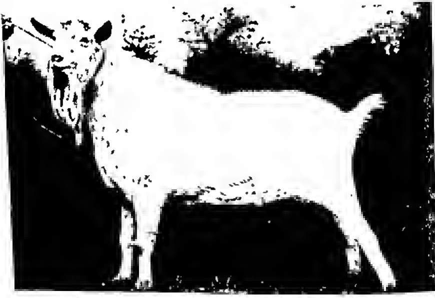


11. This pleasant British Alpine milker would stand better for her photograph if her hooves were trimmed by regular exercise on hard ground. 'Dutch clogs' are apparent on her near hind hoof, but the 'back on her heels' stance is typical of the goat whose feet are maintained by the paring knife instead of exercise. She was *bred* by Mr. Egerton and gave 4,200 lb. in 365 days

12. 'Garrochead Gallant.' Stud male of the Dhunan herd of Anglo-Nubians, on the shores of the Isle of Arran, off the west coast of Scotland
Breeder, Mrs. Duncan; owner, Mrs Laird



13. Breed Champion RM3 Mostyn Marceline BS 8713 P, Champion at the Royal Show in 1954 and 1955, and the most perfect example of the work of the pedigree breeders that is illustrated in this book. Her milk is used for rearing *piglets*. Owner and breeder: Miss Mostyn Owen



14. Mostyn Messenger S1352—a pure Saanen male of outstanding quality—exported to U.S.A. Few male goats are illustrated here because appearances are seldom a reliable guide to worth in the male

lighter on labour and feeding and the goat's digestion, and makes a heavier job for tbe milker.

Under most conditions, unfortunately, the control of goats requires more than a good command of their mental and physical comfort—it needs fences.

Any fence less than 4 ft. high will be jumped, but over 3 ft. 6 in. higb it will not be cleared by the milkers, who will bruise and leave portions of tbeir udders on the top of the fence. The only exception to tbis rule is the electric fence, wbich goats are understandably loatb to jump even at 3 ft. 6 in. A standard 4 ft. stock fence, with seven wires spaced at 6-in. intervals, will bold goats of a reasonably placid disposition so long as the wires remain dead tigbt. Eventually tbe goats will force their way tbrough tbe wires. At any time a sudden urgent incentive will send most goats over tbe top of a 4 ft. fence of this type. In theory it is possible to keep wires taut, but the theory ignores the fact that wire expands and contracts witb cbanges in air temperature; if tight on a hot May afternoon the wires will probably snap in the frost of the following morning, unless they are 6 gauge or heavier.

Wire-netting fences give a great deal of pleasure to goats, who derive exquisite satisfaction from massaging tbemselves on the netting. The procedure is for the flock queen to tbrow her full weight against a section of fence between two posts, and to press ber flank slowly along the condemned section; each member of the flock follows her, and then she will take another turn; the game goes on for hours every day and for as many days as the netting lasts. When the section has collapsed and the goats have had their fill of the crops on the other side, they lie down to cud on the ruins, whicb provide that degree of insulation from the earth which goats crave. The hard, ugly glint that appears in the eyes of some farmers when goats are mentioned is often due to the pleasure that wire netting provides.

If you run two lines of barb along the wire netting it spoils the fun, but usually does some serious damage sooner or later.

With fences of the Rylock and Bulwark type goats adopt a rather similar technique; they provide massage in the first instance; but with fences of this type it is sufficient that the fence be given a slight slant, at which stage the goats accept the convenience of the ladder steps provided by the horizontal wires, and go over the top. There is then the added embarrassment that they cannot get back again to their own ground when occasion demands.

The most generally applicable solution to the fencing problem is a

4-ft. fence of chain link, with posts at 6-ft. centres, with two or three support wires. The chain link can be either 2-in. mesh and 12½ gauge or 3-in. mesh and 10½ gauge. It must be strained.

The method of erecting this fence is as follows: after lining up and erecting the fencing posts and putting the support wires up at 4 in. and 4 ft. 4 in. above average ground level, link up the 25-yd. sections, in which the fencing is sold, for the required distance, and lay the fencing flat down beside the fence. If the fence passes over any large humps or hollows the wires of the chain link are unlocked over the appropriate sections at both top and bottom and twisted up or down to give the required curve to the bottom line of the fence. Then they are relocked. Now fix one end of the fencing to one corner post and staple a 4-ft. length of 3-in. by 2-in. timber across the other end of the fencing at a point which is about 3 yd. plus 1 yd. for every 25 yd. of fence length, from the other corner post. Then take a straining wire from the dead centre of this piece of timber to the corner post, taking care that the wire doesn't pass through the fencing. Finally strain this wire, feeding the end round the corner post until the fencing is rigid. Make fast the straining wire and staple the loose end of the last 3 yd. of the fencing to the corner post; should the fencing subsequently slacken, straining on the one wire only will tighten it once more.

An electric fence is satisfactory for temporary fencing, but requires to have three live wires at 15 in., 27 in. and 40 in. above ground level; these heights may need adjustment for large or small goats and Plate 27 shows the desired height relationship between fence and goat. The goats must be made acquainted with the potentialities of the fence and learn to respect it before the fence is charged with the duty of holding them. If they are allowed to break through once they will accept the sting as the necessary price of liberty and do it again. Male goats sometimes appear to be entirely devoid of a sense of pain, and their control can never be entrusted to an electric fence.

In more permanent forms of fencing, where a solid top bar is a feature of the design, the height should be increased to 4 ft. 6 in., a height which is suitable for all gates into goat enclosures.

In pale or rail fences the distance between pales or rails should be under 3 in. or between 7 and 8 in., to avoid a goat or kid trapping its head in the space. The wider spacing is not kid-proof. The same limits apply to the distance between rigid bottom rails and ground level.

No type of hedge associates well with goats. A well-kept hedge of

Rhododendron ponticum bears up best under the relationship; goats accustomed to the sight of it do not eat rhododendron, which is poisonous to them, but a newcomer to the flock may do so; and the accustomed flock will reconnoitre and wriggle a way through if it is possible to do so. A mature beech hedge of 5 ft. or more high will sustain little damage if alternative leafage is available; if grown in the continental trellis style, such a hedge will be goat-proof as long as it lives; but the normal double row beech hedge will usually admit a determined goat. Thorn and blackthorn hedges may hold goats as long as they live and a pure blackthorn hedge will survive many years with goats; but they are rare and the normal thorn hedge will not stand up to persistent goat browsing. A yew hedge is too dangerous to test. A holly hedge is a goat's paradise. Barberry is also eaten but not avidly. In general, hedges may control passing goat traffic but not persistent attack.

The effectiveness of stone walls as a barrier to goats depends principally on the roughness of the surface. The width of the top is of no significance. Nothing under 4 ft. sheer height is any barrier at all; beyond that height the goat cannot make a clean jump (billies to 5 ft.); but if the surface of the wall is rough with a few projecting footholds they may run diagonally up anything up to 6 or 7 ft. As with all goat control, much will depend on the social life of the flock: (an elderly flock queen is not given to acrobatics,) and the degree of frustration they experience in their confinement.

While the use of barbed wire in goat fences is generally neither safe nor effective the addition of one strand of barb wire at 5 ft. on the 4-ft. chain link fence makes a combined goat-and-deer-proof fence which is quicker to erect and requires less maintenance than a classic all-wire deer fence. Where goats are kept on a hill farm, such a fence has been held eligible for subsidy under the Hill Farming Acts.

In general, it can be said that a fence that is goat-proof is also deer-proof and vice versa. Few deer fences of the 11-wire type are deer-proof or goat-proof; but most of them are a sufficient deterrent for practical purposes.

Many a poor man cannot afford to fence against either deer or goats. The deer carries away a ·22 bullet in its guts and the goat goes on a tether.

One goat alone on a tether is not a happy sight. A number of goats tethered within sight of each other can form a contented and productive community. Granted that the tethering system has been much abused and that it is very expensive in labour, it provides a *perfectly*

feasible aod satisfactory method of goat control under some circumstaoces. Much of the unqualified objection to tethering is rooted in plain common soobbery.

The commooest form of tether is the picket tether, where the goat is tied by collar aod chaio to a stake driven into the grouod. The collar is the better for being extra wide; the ehain must have swivels at both ends aod be reasonably light. It is belpful if the chain is made of three easily detachable 6-ft. lengths, so that the tether can be leogtheoed as the day progresses, without excessive fumbliog. The chain is attached to a ring which rides and revolves freely in a collar rouod the top of the stake. The stake must be driven in until the ring is flush with the grouod, or the top of the stake will foul the chain. If the local blacksmith is too busy mendiog tractors, tetheriog equipment is available from the specialists in goat equipment who advertise in the appropriate papers. Pig tethers are adaptable.

The main soags of this form of tether are that it makes for uneconomical use of ground and can only be used on patches of grass and soft herbage. The goat grazes a ring at the end of its tether and soils the circle around the stake; if you divide a field into rings which do not overlap, you leave a lot of ground ungrazed. As a light chain will snag on any obstacle from a fruiting dock stem upwards, the ground on which it will not snag can be guaranteed devoid of the harder types of herbage in which goat digestion delights. In warm weather the picket-tethered goat is often eoveloped in a thin haze of flies which detract from its peace and conteot aod from which there is no escape. A spray with insect repellent—not DDT or BHC—helps matters in this respect.

The alternative form of tether, known as the 'running tether', is slightly more cumbrous to establish, but coosiderably more satisfactory io actioo. Esseotially the running tether consists of a fairly short length of chaio—not more than 3 ft., and not less than 18 in.—with a swivel, collar and goat at one end, and at the other eod a swivel ring which runs along a wire stretched taut aloog the grouod.

The wire may he of any length from 6 or 7 yd. up to several hundred. If of a short length, the ends of the wire will be held hy two stakes, the heads of which are driven flush with the ground. Alternatively a long wire may be lightly strained from the fencing posts across the corner of a field or right across a narrow field. In this case the goats' chains must he sufficiently short to prevent any possibility of their even considering jumping the fence at each end. A long wire can also be strained hetween two posts planted in midfield; hut in

this case a piece of wood, longer than the length of the tethering chain and goat combined, must be tightly stapled to the wire at both ends to prevent the goat getting caught up on the post. Such a piece of wood can also be stapled on to the wire at any point along its length to divide it into tethering sections. In this way a dozen or more goats may be tethered along the 'grazing face' of a forage crop; the daily move forward will only call for the removal of the end posts and one strand of wire; the cost of such equipment will be in the nature of 10s. As against the electric fence it has the disadvantage that you must spend a few moments attaching each goat to its tethering chain each day; and the advantage that there is no electric circuit to be shorted out by a heavy wet crop.

The running tether uses a short length of relatively heavy chain which does not snag easily: if it does snag, the goat can apply a great deal more force to release herself than is possible on the picket tether.

The running tether has proved quite satisfactory for strip grazing of kale, with grazing periods of up to four hours. It has proved entirely satisfactory for goats eradicating thistles and docks from new leys for grazing periods of twelve to fourteen hours; it can be used with a measure of watchfulness right through the midst of a strong old growth of brambles and briars. Plates 5 and 6 shows some goats accustomed to unrestricted free range during their first day on running tethers. There are no objectors.

How much wind and rain the tethered goat can tolerate depends on the kind of fodder she is getting. It is quite proper for the owner of the goat receiving 4 to 5 lb. of concentrates a day to rush her corn-bin back to the goat-shed as soon as a rain cloud darkens the face of the summer sun. But sterner diets make goats of sterner stuff. If an elementary shelter is strategically placed at the windward end of a running tether, most goats can be tethered on coarse weeds and grass most days from May to September.

Flies and sun are another problem. As far as the former are concerned, the goat on a running tether is little worse off than the goat with 'free range' over a few low-lying acres. Sun intensity in Britain seldom reaches the goat's limits of endurance, provided the goat has access to water; but in damp, windless heat the goat is best kept in the shade during the worst of the day: it is not the sun that troubles the goat so much as hot humidity.

For any goat-keeper who is not a pedigree breeder of the first class there is no purpose served in rearing male kids for anything except meat. There is always an ample supply of pedigree males at prices

well below the cost of rearing. Readers who care to disregard this excellent advice must accept the consequences and a very troublesome task of control.

From the age of three months the male kid may be capable of service; outside the normal breeding season it is unlikely that he will give effective service, but the risk exists of spoiling one of the female kids with whom he is running, or all of them for that matter. For this reason males are usually segregated from the age of three months; the old males living in isolation are apt to maltreat male kids, so that each male kid has to be reared by himself and have all his food carried to him and all his social education provided for him by the goatherd. He must be taught to lead, and to obey, and not permitted to play. Above all, he must not be teased.

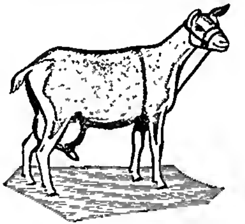


Fig. 6. The Spanish Halter. A device used in both Spain and Germany on goats grazing mature-orchards and olive groves to prevent them reaching up into the branches

The adult male is dangerous to all children and to any man or woman who is afraid of him: he is a nuisance to anyone who he thinks might be afraid of him. To keep him in manageable condition he must be handled and exercised regularly and very firmly. The method of reducing an unmanageable billy to subjection has already been detailed.

Fences to hold adult males must be at least 4 ft. 6 in. high; if with solid top bar they need to be 5 ft. Yarding, stalling equipment, gates, etc., must be of the strength appropriate to control cattle or ponies.

Chapter 6

HOUSING

Over a number of years I have been walking, through wind and rain, over the downs, over the hills of Northumberland and Galloway and among the mountains of Wales and Scotland. In all those places, and in all the wind and rain, I have stopped every hour or so to light my pipe; very seldom have I failed in the attempt. Wherever there is a wealth of ground feature and rock there is a wealth of nooks and crannies wherein one can light a pipe in a wet gale. In such nooks and crannies the wild goats make their bed. The first duty of a goat house is to provide equivalent shelter; quite a number of goat houses fail to perform it.

The wild goat is a great deal more particular about its dormitory than the deer, or hill cattle or hill sheep. Every dormitory of the wild goat that I have seen, in Galloway, Wales and the Scottish Highlands and Islands, has boasted a carpet of a depth and insulating capacity unobtainable even at the Dorchester Hotel. Goats originated the principle of under-floor heating, of which the finest example I have seen was in an abandoned shepherd's cottage, near Back Hill o' the Bush in the Galloway hills, the winter quarters of the feral goats which summered around the Monument on the Newton Stewart road. Here the goats reclined on a 4-ft.-deep compost of accumulated droppings.

The goats in the caves of Carradale Island had a bigger area to cover and had not achieved the same depth—but even the summer couches of the goats of Lochbuie in Mull were quite luxuriously lined. The need for luxury in this respect is clearly considerable; the need may explain why the feral goats return each evening to the same sleeping place, and the domesticated goat returns unbidden to its shed. When she has too soft and rich a fill of early summer herbage, or when snowstorms and torrential rain prevent her getting an adequate bulk of winter roughage, it must be a real problem to the thin-skinned goat to keep her belly warm at night.

A further nid to the solution of this prohlem is found in the social nature of the feral goat dormitory. On warm summer nights each goat has its separate couch, hut if conditions are cold there is much sharing of heds, and only one flank of each goat is exposed to the night air. Undouhtedly many cases of pneumonia, gastro-enteritis and mastitis might never develop if the goat were free to provide herself with a companionahle hot-water hottle on the critical eveoing!

These features of the feral goat dormitory are not necessarily desirahle in the goat house because they are natural. But there is little douht that they are natural because they are desirahle.

Our goat houses must inevitahly be, to some extent, a compromise hetween that which is most comfortahle and health-giving for the goat and that which is most convenient and economic from the point of view of human management. The design of cow houses has been inspired, most markedly, hy the desire to ease the disposal of the dung the cow makes while she is being milked, fed and sheltered. But goat houses are designed for the prime object of eoahling the feeding of coocentrates.

Under most systems of management it is ecooomic to feed the goats concentrates at some time of the year. But the appetite of the goat is so elastic that one strong and hungry goat is quite capahle of eating three or four times the ration prescribed to her, with ill consequences to her own health and the productivity of her companions. So goats can seldom be trusted to share their concentrates equitahly at a trough, like cattle and sheep. They must be isolated from one another when consuming concentrates.

There is a remarkahle unanimity about the layout of goat houses as a consequence. The goat house consists, essentially, of a feediog passage at which the goat is either held hy the neck in a 'heck' (as in the front of kidding crate, p. 233), tied in a stall, or penned in a loose hox, according to the degree of comfort to which her productivity entitles her.

The heck system requires 7 sq. ft. of floor area per goat, and is the prevalent system where the average daily yield is under 3 pints per head (e.g. in Morocco and the Pyrenees). It permits the goat a hare minimum of movement and comfort and is not generally practicahle unless the goats are on range for the best part of the day. The fidgety goat cannot produce satisfactorily if nndnly restrained.

The stall system requires 10 to 16 sq. ft. of floor area per goat, and is earned hy goats giving up to 6 pints a day. Though movement is still restricted, goats can give satisfactory production on this limited

liberty even when all their diet is hand fed. It is in fact the commonest system of goat housing in cool goat-dairying districts.

The loose-box system calls for the provision of 20 to 30 sq. ft. per goat, but the yield of the goat must rise to at least a gallon a day before it can justify the cost of the extra liberty and shelter the loose box provides. With the extra liberty and shelter the goats can produce high yields on a hand-fed diet. As it isolates the goats more completely and securely than any other method, the loose box is a very convenient arrangement for feeding concentrates in large quantities, rationed to individual requirements.

Though goats should be isolated while being fed concentrates, there appears to be no great advantage and some disadvantage in isolating them at other times. Goat houses which are nothing more than dormitories require no partitioning whatever, but a floor area of about 12 to 15 sq. ft. per goat. Accommodation for controlled feeding of concentrates and uncontrolled feeding of other food may be provided separately or under the same roof. If provided under the same roof, the floor area allowance per goat will be 20 to 30 sq. ft.

No arrangement is cheaper to provide than the heck system; with it the covered feeding yard and dormitory—the communal goat house, to give it a label—cannot compete. In a cool wet climate, such as Britain, it is quite as expensive to provide a communal goat house as it is to provide stall housing, though there is less partitioning to erect there is a greater floor area to be adequately sheltered and insulated. In drier and warmer climates, such as that of Spain, the communal goat house does not have to provide such a high standard of shelter, and it replaces the stall system. Under the similar Australian conditions it could do so equally well.

In comparison with the loose-box goat house, the communal goat house offers a high standard of liberty, of social amenity, interest and comfort at lower cost. This type of housing accords well with the methods of control and feeding advocated in this book, but is subject to one serious objection—the amount of bullying it permits.

Bullying does not normally reach serious proportions in a flock with an active social life and a recognized flock queen, unless some of the goats are horned and some hornless. If this is the case, either the horns or the communal goat house must be dispensed with. Also, as new-comers into a flock have to 'fight their way in', and the process takes some time in a large flock, the communal goat house is an unsuitable form where goats are regularly boarded or there is much buying and selling of adult stock.

The first duty of the goat house is to shelter. Here we come to the standard instruction that it must provide plenty of fresh air but not draughts. The instruction is misleading, because the more fresh air there is in a house the less cause there is for draughts, and especially for the cold down draughts, which are the most dangerous and discomforting. There is very little draught in the hollow on the hillside, but as soon as the warm air of a goat shed comes in contact with cold, thin-skinned roof and walls, a vicious down draught is set up which strikes on the goats' backs; at the same time, cold air streams into the warm shed through every chink in the building and, being heavier than warm air, promptly seeks the floor where the goats are lying, and swirls about them.

There is no point in paying lip-service to fresh air. Either we want it or we do not want it, or we want but a little of it. If we want a really warm shed we do not want fresh air; unless we provide a central heating system the goats heat the air; if the air is warm it is not fresh. Fresh air is the same temperature inside the goat house and outside it: if that is the temperature you want your goat house to maintain, you want fresh air; otherwise you want as little fresh air as possible or a very restricted supply.

The peculiar reverence in which twentieth-century Britain holds fresh air must not deter us from thinking about the stuff. Fresh air has a full content of oxygen; it is very unlikely that in the cosiest goat shed the goats will be in the least embarrassed by shortage of oxygen, so that aspect of the matter can be forgotten. Fresh air has a relatively low moisture content, at least in cold weather, and can absorb moisture from the goats' lungs and skin. Stale, warm, moisture-laden air can absorb less. The effect of such a 'stuffy' atmosphere on the goat's lungs is not very clear; but it is probably true to say that a goat accustomed to such an atmosphere is liable to chill and pneumonia, if suddenly exposed over long periods to cold dry air. The effect of a 'stuffy' atmosphere on the goat's skin is visible and quite well known: the skin exudes oil which renders the coat exceedingly smooth and glossy and inhibits the development of the woolly underfluff. For this reason the rugging of goats, even in summer time, is an old trick to produce the show-ring 'bloom'.

Fresh air has a low bacterial content; stale, wet air is rich in bacteria. But, apart from some rare forms of catarrh and a number of common but sub-clinical infections, no important goat disease is airborne. From this point of view the worst that we can say of stale air is that it is more difficult to produce clean milk in it.

In effect, fresh air in her shed is good for a goat who has to spend a substantial proportion of her life outside; stale air is suitable for a goat that is going to spend most of her life indoors. It is perfectly true that fresh air is more challenging and invigorating to the goat's system; that a goat that lives and sleeps in the fresh air attains a *joie de vivre* beyond the reach of the other. But such a goat is not necessarily more productive.

In fact those who serve the Mammon of exploitation must serve faithfully. To produce heavy yields over long periods and through the winter the goat must have a large intake of concentrates and water. From the point of view of heat production the term 'concentrates' must include all foods in which the percentage of starch equivalent is more than half the percentage of dry matter. A glance at the table of Feeding Values will show that such 'bulk' foods as kale and mangolds are in fact more concentrated than oats and some of the oil cakes. These 'succulent' foods are more hostile to heat production than the concentrates, because their nutrients are accompanied by so much water as to direct them towards the udder and away from the body reserves; moreover, the water content is cold and has to be heated up. The more watery roots contain barely sufficient energy value to heat their own water content to blood heat sufficiently quickly to suit the high speed digestive system of the goat. Such foods, if fed in quantity through the winter, must be fed in a warm shed and therefore in relatively stale air. Organize a good thick fug in the goat house and keep it there. A daily spell of *brisk* exercise is all that the goats need to know of fresh air in winter time. In summer their goat-house design must allow for sufficient ventilation to keep temperatures at a reasonably comfortable level, but this is an easy matter to arrange.

In the house of goats that are to forage out through the winter let there be no vestige of fug. Shelter the goats from wind and rain and snow, but let the air they breathe under cover be no warmer than the outside air. A dutch barn equipped with sleeping benches and a wind-screened feeding rack is the sort of building that will meet these requirements. In such a building there are no down draughts from cold walls and roof because roof and walls are no colder than the air. These conditions will not make for high yields, but they will make for economic and healthy lactations.

Unfortunately there are not a great many goats living under conditions where they can get a substantial proportion of their diet from the natural wastes of winter. Most of their food, and the fuel to keep

them warm, must be hand-fed and costs money. The warmer the goats are kept the less of that costly feeding goes up, as it were, in smoke. So there is a demand for warm sheds for foraging goats; in these there must be a regular inflow of fresh air, or the goats will be unfit to forage outside. To produce a satisfactory shed of this kind for a small flock is undoubtedly more expensive than to feed more hay in an open shed. It is never necessary to provide a warm shed, but the main considerations governing the design of these sheds are given here.

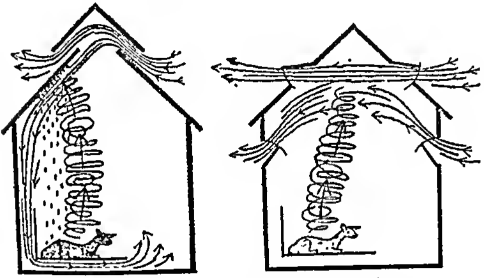
Light wooden structures or houses made of corrugated iron or asbestos sheets all tend to develop chinks in old age. Unless very well ventilated they produce down draughts in cold weather, when condensation on roof and walls will add to the discomfort of the goats. The area of the house immediately against the walls is virtually uninhabitable in cold weather, and the floor is too draughty to be slept on.

The problem is depicted in Fig. 7. Ridge ventilation of a house of this type is worse than no ventilation at all, for ridge ventilation fails to extract the warm air before the warm air has made contact with the cold roof surfaces and set up down draughts and condensation. Though extracting some warm air from one side of the house, ridge ventilation accelerates the cold down draught on the other side. The warmth of the goats on any one side of the house depends on wind direction: they will be quite cosy one night and lying in a freezing down draught the next. The provision of hopper-type windows, opening inwards, just below eave level, in addition to ridge ventilation, diminishes down draught, but does not stop it. No other type of window below eave level can do more than intensify discomfort.

Roof-lights or fixed ventilators on opposite sides of the roof provide the best basic ventilation system. The ventilators on both sides of the roof must always be opened the same amount, unless, perhaps, when a steady gale is blowing from a settled quarter. Ventilators must open outwards. The exact positioning of the ventilators will depend on the pitch of the roof and the ground plan, but generally they should be nearer the eaves than the ridge, in order to extract the warm air before it condenses on the cold roof. Hopper-type windows, below eave level, will assist this system; but the windows must open inwards and the eaves must have a deep overhang to prevent driven rain from blowing in on to the goats. Other types of windows are suitable for summer ventilation only.

Apart from a suitable ventilation system, the best hope of warm

comfort in a thin-skinned goat house lies in insulation of the walls and roof. As only a small minority of human dwellings in Britain can boast of the use of insulating materials, it may seem a little ambitious to recommend insulating a goat house. But in fact modern insulating materials are very cheap, readily available and easily handled. In most cases it will cost less to insulate a goat house with material to last its lifetime than to give it one coat of paint. Three main types of material are used—mica flakes, glass fibre blanket and aluminium foil; all of them are fire-proof, rot-proof, non-absorbent and deterrent to vermin. Very poor meadow hay, loosely packed, is also a good insulator, which lacks the permanent virtues of the others. Mica



(a) (b)

Fig. 7. The ventilation of thin-skinned goat house: (a) ridge ventilation, (b) roof-light and hopper windows

flakes are laid loose, $1\frac{1}{2}$ in. deep, on flat or nearly flat surfaces. They are the cheapest and easiest form of insulation for flat concrete roofs, being covered with paper and sandwiched between two layers of concrete; they operate by trapping a quantity of still air in insulated pockets. Glass fibre blanket works the same way, but can be draped over or under sloping roof surfaces. It is rather unpleasant to handle: either use leather gloves and close-woven overalls, or bare hands and arms and wash them in cold water when you are finished. Aluminium foil is not a blanket insulator but a heat reflector. The effect it produces is similar to that produced by the other insulators, but it is possibly better than any for retaining heat in a well-ventilated goat

house and for keeping a house cool in hot sunshine. It loses its properties if laid in direct contact with other metals, but is ideal for lining under felt roofs. It is tacked on to the wall or roof surface in overlapping sheets.

Wood itself is a good insulator, and match-boarding is sometimes used for lining corrugated-iron sheds, but it is an expensive form of insulation.

The conversion of old stone- or brick-built buildings is usually the best means of providing warm shelter with a minimum of draughts. It is also usually the least hard on the pocket and the appearance of the countryside. But if new buildings are required they need not necessarily be very expensive or ugly. Bales of straw make good building bricks; they can be secured in position between two lines of fencing. If set on a dry foundation, thatched on the outside and given a roof with a generous overhang, they will last for fifteen to twenty years. Thatchers are no longer the rare birds they used to be, and in England the local Council for Rural Industries will usually be able to provide a list. Six tons of straw will provide walls and gable end for a twenty-goat house.

In districts where straw is dear, stones tend to be plentiful; for a warm, well-insulated shed there is much to be said for the primitive rough-stone house. It is not beyond the capacity of the average handyman to construct: local craftsmen will charge about £1 per square yard of wall surface. The wall is made 3 ft. wide at the bottom, tapering to 1 ft. 6 in. wide at the top; the inside of the wall is kept straight and all the taper is on the outside. Cement is used on the inside of the wall, but on the outside only for the last foot at the top. Between the inner and outer stones at the bottom turfs are rammed as building progresses. At a height of 3 ft. strap stones are laid at intervals across the width of the wall; from that height upwards the interval between inner and outer stones is filled with small stones and gravel. The outside corners are rounded, and the walls are taken to 6-ft. height or a little more all the way round—with no gable end. The roof, which must be angled or rounded at both ends, may be either felt or thatch. The width of this type of house must not exceed twice the height of the walls and the roof must be rather steeply pitched. Good models of this type of house are common in the Hebrides.

Concrete-block construction is now relatively cheap provided the erection is not done by a builder. If there is no objection on the grounds of appearance, cavity blocks make a good goat house. Double-wall construction is preferable but single wall will do. Flat

roofs are the easiest and most satisfactory for concrete-block buildings, but they must be insulated. With flat roofs two hopper-type windows or ventilators facing each other, opening inwards, with their tops at ceiling level, give the most satisfactory ventilation.

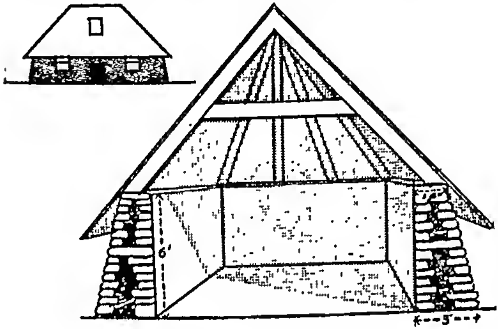


Fig. 8. The rough stone house

Good advice is more plentiful than hard cash and inevitably many goats will have to put up with more or less ramshackle houses and a thoroughly perverse system of ventilation. To minimize the discomfort and danger, concentrate attention on the goat's bed. In loose boxes and communal goat houses the simplest solution is to provide the goat with a sleeping bench. This in its simplest form consists of $\frac{3}{4}$-in. boarding, 4 ft. long and 2 ft. wide for a single goat (double the width for two) set on legs or propped up on what-have-you, some 9 in. to 2 ft. above floor level. This should be set a foot or more away from the walls of the house, to avoid wall draughts, and may be improved by the addition of a 1-ft. backboard, or by being set against a partition wall. The provision of wings at either end may be helpful in a draughty communal house, but is seldom necessary in a loose box. Where down draughts are a problem, the sleeping bench can consist of a box, 3 ft. 6 in. to 4 ft. long, 2 ft. to 3 ft. wide and 2 ft. to 4 ft. deep, set on its side and raised off the floor. On such a sleeping bench a goat can sleep in an open field a great deal more comfortably than most goats sleep in a warm shed.

The stall system of housing does not lend itself to sleeping benches.* You can provide a raised wooden floor to the stall, but it will rot and stink and grow slimy very quickly, even if covered with straw or peat. Alternatively you can provide a raised slatted floor, a piece of equipment which all goats loathe: if you cover it with straw it will feel less repulsive to the goat's feet and more warming to its belly; but there is a lot of work involved in moving straw and slatted floor sections to clean underneath them.

If the house is built with well-insulated walls and roof and is substantially free of draughts, there is no reason why the goats should not sleep on the floor. Many goats have to sleep on floors in a whistling icy draught. In either case the nature of the floor is important. It should be dry and well insulated. This end is attainable in man's way or in the goat's way. Man's way is to lay down a waterproof concrete floor, sloped to a central drainage point, and to cover the floor thickly with straw. The goat's way is to lay down a hot bed of accumulated droppings, which absorbs and evaporates the moisture in the urine and renders inoffensive the urine's nitrogen content.

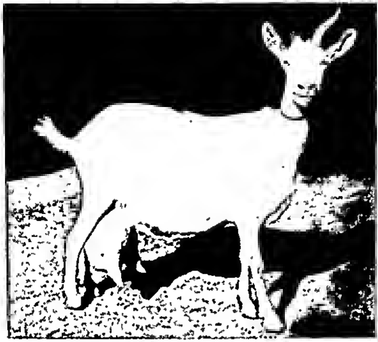
The goat's way produces the most comfortable bed and the most sweet-smelling goat house under normally favourable conditions. The goat's way is also most economical in labour and materials. But for its proper functioning the hot-bed system of drainage needs a porous floor. High-yielding milkers on a sappy diet have an intake of 4 to 6 parts of water for each 1 part of dry matter and an output of about 10 parts water to 1 part dry matter. This is too much for the absorption powers of the natural hot-bed, even on a porous floor. A 2-in. layer of peat moss for each 2-in. layer of droppings will make a more absorbent bed and will suffice for normally fed goats.

The hot-bed is very rich in bacteria of the coliform type. As the presence of such bacteria in milk is a standard indication of bad dairy hygiene, it follows that clean milk production is rather more difficult where a hot-bed system is used.

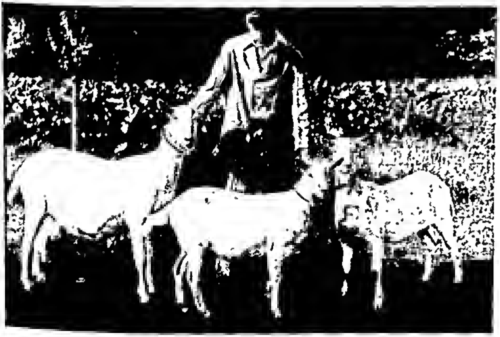
Even the stalled goat distributes her manurial largesse over a remarkably wide area, and the quantity of straw needed to keep her dry on a concrete drainage floor is a very serious consideration. Unless this straw can be composted with droppings and liquid manure into a valuable fertilizer for use on the holding, or for sale, the straw is going to be a very heavy charge on the enterprise.

In laying down a concrete drainage floor for a goat house, conservation of liquid manure should always be arranged. The other

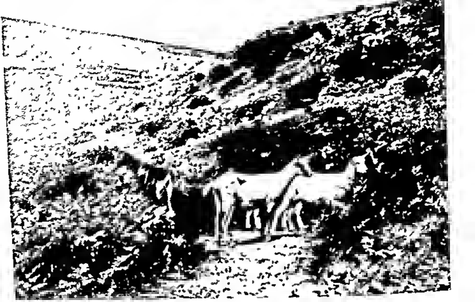
* But see page 325 for a novel solution.



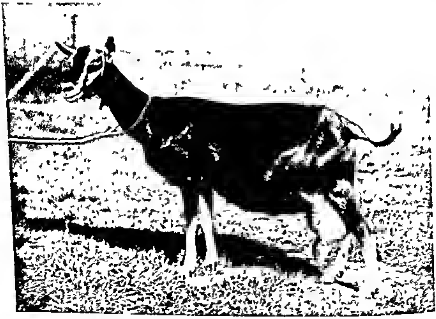
15. Bitterne Joke, BSR 958. No beauty but a record buster. The first 'R5' who gave 6,422 lb. *in* 365 days in the midst of the 'V' bomb blitz. Her distorted horns are the legacy of an abortive attempt to disbud her as a kid. Deep and slab-sided, she is typical of the goat adapted to heavy yields on a succulent diet. *Bred by* Miss K. R. Barnaby; owned by Mrs. Howard



16. Malpas Melba and two of her kids—a triumph of selective breeding. *Her yield* of 6,661 lb. in 365 days has never been surpassed, and much of her ancestry is shared by the most outstanding milkers of the past decade. *She produced over 5,500 lb.* in three successive years, and twice in one lactation lasting two years. Her conformation, to which the photograph does less than justice, was near classic. Her lifetime yield was 33,786 lb. Owner and breeder, Mr. Egerton



17. What can cash the natural coverage of this typical piece of Britain better than goats? Goats won't eat the brackens in the foreground but will trample them in the search for the brambles, goosegrass and bindweed which grow amongst them



18. RM6, Twynkel. Holder of world record for Official Lactation Period of 365 days, with a yield of 6,518 lb. Life yield 26,735 lb. at 3·7 per cent b f. in 4 lactations. Weight 180 lb. Average daily food intake, 20 lb. of dry matter and 7 gallons of water (11 lb. dry matter per 100 lb. bodyweight). Slab-sided and immensely deep, she is the epitome of the high yielder on a very 'wet' diet. Owners, Miss Salmon and Mrs. Short; breeder, Mr. B White

main points to consider are: that it is generally inconvenient to drain a pen through the doorway; that goat droppings and straw are a wonderful combination for pipe-blocking, so drainage channels should be open; that one pen or stall should not drain into the next; that the drainage grooves so familiar on cow-standings are inappropriate in goat sheds where the first goat dropping to land in them will frustrate their purpose. The provision of a two-way trap to divert the liquid manure into, and the washing-down water away from, the liquid manure tank, is usually an unnecessary refinement in goat houses. To damp the quantity of straw produced from a concrete-floored goat house, to the state in which it will compost satisfactorily, requires far more water than the goats will produce; so the addition of washing-down water to the liquid manure tank will not go amiss.

The chill that strikes through an uninsulated concrete floor will reach through several inches of straw. If a new floor is being laid it is well worth while to insulate it by one or other of the following methods, neither of which call for much extra expense or labour.

Method 1. Lay the foundations of the drainage floor in the form of heavy shingle or large chippings, no stone of which is smaller than a hen's egg. Lay this material, unmixed, to a depth of about 6 in., and form it into the rough design of your drainage floor. On to this bed of loose stone pour a very sloppy mixture of 4 parts sand to 1 part cement, adding to the mixing water recommended quantities of a compound known as 'Cheecol'. Allow 1¼ to 1½ cwt. of cement for each ton of stone. This mixture will percolate through the bed of stones, lodging only where stones touch one another. It hardens quite quickly and will give you a honeycomb of still air on which to finish your floor; have no fear of its strength, for the system is used on arterial roads. For a drainage floor it is preferable to finish the surface with a waterproofing compound (e.g. Sealocrete). But Method 1 can be modified to produce a porous floor, in which case you will finish with a mixture of 1 part cement to 3 or 4 parts fine clinker and spread the surface with earth or sand.

Method 2 requires a tractor. Thoroughly till the building site to a depth of 9 in. With a post-hole digger excavate 6-in. diameter post-holes at 2½-ft. intervals over the whole site. Fill these holes with concrete. Then as quickly as possible, and with the minimum of trampling, lay a first layer of concrete straight on to the loosened earth. Finish your floor in the normal way, with a waterproof sur-

face. In due course the earth subsides, leaving the floor supported on concrete pillars.

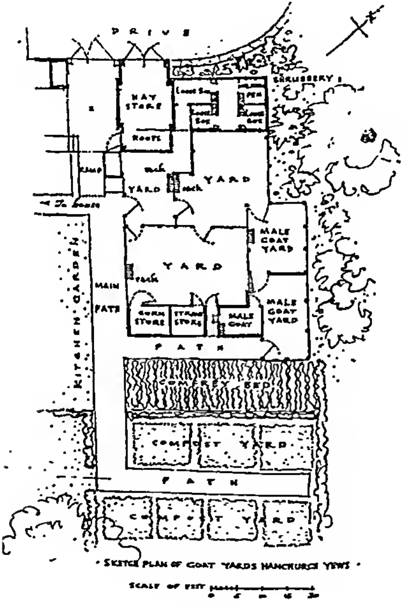
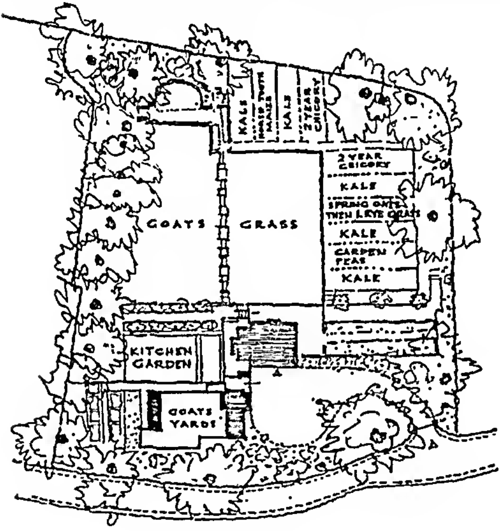


Fig. 9a

Such a thiog as a standard goat house does not exist. The expenditure of architectural thought on goat houses has been small io quantity if excelleot in quality. It has therefore seemed more helpful to



SKETCH PLAN OF
HANCHURCH YEWS

SCALE ONE FIVEHUNDREDTH

Fig. 9b

provide basic data and food for thought than specific designs for imaginary, and probably non-existent, conditions. Plans of small goat houses and open-fronted shelters are available from the British Goat Society.

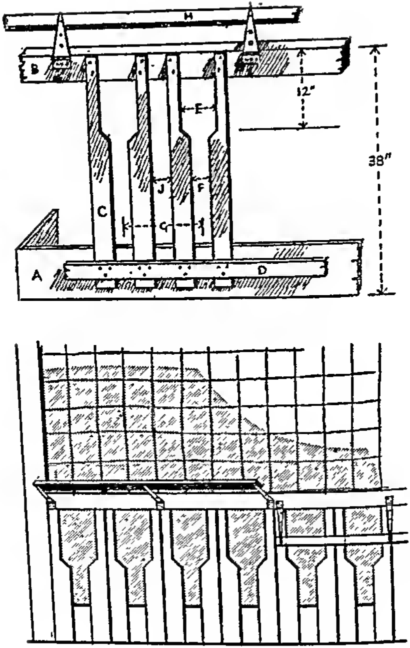


Fig. 10. The American type goat-feeding rack
(After I. A. Richards)

Plate 10 shows an excellent example of the loose-box system of housing and a number of useful details. Note the insulation.

Fig. 9 illustrates a practical layout for goat-yarding, designed by a goat-keeping architect with many years of practical experience. A yard of this type facilitates the feeding of bulky foods—a most laborious task when goats are fed in stalls or loose boxes. It permits development of the social life of the herd, so necessary to good control, and quite impossible for hand-fed goats kept by other means. It keeps the hand-fed goat in a healthy environment of fresh air and exercise.

The system presented here is an unusual solution to a number of goat-keeping problems, which has stood the test of time and milk recording. It has every advantage over more popular systems of stall feeding and a great many advantages over the less satisfactory forms of free range—not the least of these advantages being that the whole of the goats' output of dung on a bulky diet is available for composting and application where required. Most of it is deposited in the open air and open spaces of the yards, where it is most easily collected.

Fig. 10 illustrates an American type of goat-feeding rack which is usefully versatile. With the locking bar lowered it becomes a feeding rack in which the goats can be isolated for concentrate feeding, and held for milking if required. With locking bar raised it becomes a free-for-all hay rack, in which the goat can nose around for the bits she most fancies but has great difficulty in wasting her second choice. The degree of isolation provided with the locking bar lowered is probably insufficient for feeding concentrates in large quantities and individual rations. But it is quite adequate for feeding the standard allowance of 2 lb. of concentrates per head suggested in this book.

With a 3-ft. feeding passage down the centre, this rack could be standard equipment in the communal goat house, the only other

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Fig. 10. The American type goat-feeding rack

A. Base board of the side of feed box.
B. Top batten of feed box.
C. 3 in. by 1 in. stanchion—cut out piece, 12 in. by 1½ in.
D. Foot rest, needed for goatlings and kids only to enable them to reach the head opening.
E. Head opening: for kids, 6 in.; for milkers, 7 in.; for males, 9 in.
F. Neckslot: for kids, 3 in.; for milkers, 4 in.; for males, 6 in.
G. Distance between centres: for kids, 12 in.; for milkers, 18 in.; for males, 24 in.
H. Batten on hinges, lowered to lock heads in the stanchions.
J. Where J is more than 3 in. it is filled.

equipment needed being sleeping benches and drinking bowls.

If a bigber degree of control of concentrate feeding is required, this would be as well provided by a separate milking parlour.

Of tbe smaller items of goat equipment the most important is the bay rack. The nature of tbe ideal goat hay rack is a subject of mucb controversy. Some people favour hay nets. Certainly they are portahle, useful therefore in the sbow-yard; and using bay nets it is possible, as it were, to fill the goats' bay racks in tbe field where you cut their fodder. But hay nets are a source of mnch frustration to tbe goat wbo cannot get at tbe bit of fodder she wants: sometimes the goat succeeds in pulling the bay net down and spilling and wasting half the contents; at other times tbe hay net avenges the attempt by catching the goat by a front leg. They are a source of equal frustration to the attendant who cannot undo tbe knot at tbe top, and then the hay net bas been known to aveoge tbe insult it earns, by removing the buttons from tbe atteodant's coat. On the whole, bay nets are to be avoided.

The wooden rack in general use is about 2 ft. deep, witb wooden bars 1¼ in. square, set 1½ in. apart. The hay slides through them more satisfactorily if tbe bars are bevelled from 1¼ in. wide at tbe outside to 1 in. wide on tbe inside. In making such a rack, screw the bottom of the bars *inside* tbe bottom rail of the rack, and tbe top of tbe bars *outside* tbe top rail of tbe rack. In loose boxes it is an economy to place a two-sided rack oo the pen partitions, to serve both occupants of tbe adjacent pens.

Iron bay racks of similar design are obtainable from the goat equipment specialists.

Another type of bay rack which has enjoyed some popularity is not a rack at all hut a hox, with a lid on top, fastened to the side the goat cannot reach, and a hole (7 in. diameter) in the otber side, through which the goat (hornless) puts her head and snuffs around for the hits she wants, withont wasting the rest. This device does reduce wastage, but it is douhtful if the goat enjoys eating with her head in a small, dark, dusty hox.

The same principle of free choice is honoured in the American type of rack, shown in Fig. 10—but here free choice is permitted under lighter and airier conditions and it is even more trouhlesome for the goat to waste hay. This rack is also very much handier than any of the other designs mentioned for feeding long, thick-stemmed foods such as kale, hog-weed, artichoke-tops and tree-hranches. These foods otherwise have to be chopped and fed in pails or *individually suspended*!

Drinking arrangements in goat houses appear to be rather primitive at first sight. Buckets predominate. They have to be emptied and refilled whenever a few hay seeds have contaminated the surface, for the goat is a fussy drinker of *cold* water; but she will nevertheless drink up to 5 or 6 gallons of water in a day—a lot to carry to one goat. Goats drink quite willingly out of automatic cow-drinking howls, and the more old-fashioned, ever-flowing gutter system suits them well. But goats prefer and sometimes need to have their water with the chill off; moreover, such foods as sugar-beet pulp (soaked) come in buckets, and the miscellany of gruels and skim-milk drinks which figure in the diet of high yielders also come in huckets—so huckets remain. Nevertheless, for a commercial herd, automatic drinkers and an electrically heated and thermostat-controlled supply would he cheaper.

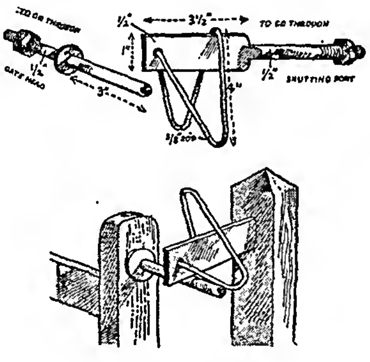


Fig. 11. A goat-proof latch

Goats are infernally inspired to be able to undo almost any kind of latch, except the simple bolt, which is an eternal nuisance to the attendant. As a contribution to goat-house equipment Fig. 11 illustrates, with more hope than confidence, a latch that is believed to he goat-proof. This is essentially a large-size variation on a common

latch which goats do defeat. Perhaps the 3-in. projecting bar might be a little embarrassing in the more compressed loose-box houses, but it is excellent for main doors and gates, which have to withstand goats.

The hard outer horn of the goat's hoof grows continuously to replace that which is worn away in the course of the goat's activities. If deprived of activities the goat will accumulate a surplus of outer horn around its hoof which is unsightly, uncomfortable and a suitable site for the agents of foot-rot. This surplus will not arise if the goat is regularly exercised on hard ground for even a short period each day. It will not occur if the goat confined to loose box or yard is provided with a hard, and preferably abrasive, stone about 15 in. square and a few inches high. When hoof-trimming does become necessary it is done with a sharp knife, bringing the outer horn flush with the sole, without cutting the sole: for the operation the goat's leg is held as the smith holds the horse's leg for shoeing. The result is inferior, both in appearance and in its effects on the health of the foot, to that achieved by proper goat-house equipment and regular exercise. Hoof-trimming should only be necessary for a goat recovering from long illness—and for other people's goats.

Chapter 7

THE PRINCIPLES OF GOAT FEEDING

In a book on dairy cattle it is just as well to skip tbe chapter on Feeding Principles, as you can get more up to date information elsewhere. The basic facts about cow feeding bave been known to every agricultural college student for thirty years and more; the minor wrinkles derived from the unceasing work of tbe agricultural research centres are absorbed into the practice of tbe big feeding-stuffs firms as soon as the scientific report is publisbed; tbe firms' graduate salesmen are always at least one jump ahead of tbe latest textbook. With goats, the situation is different.

The basic facts about goat nutrition were published in the U.S.A. in 1938, and bave been scrupulously disregarded on botb sides of tbe Atlantic ever since. Agricultural colleges do not teacb tbe facts and animal feeding-stuff salesmen are unaware of tbeir existence. Following a change of editorial policy in tbe 1950s, British Goat Society publications ceased to feature articles on international goat research. Few British goat breeders bave a scientific training or are capable of thinking in scientific terms. The few scientifically trained goat breeders wbo make their advice heard tend to trot out the dairy cow science, which they were taught and understand, witb a blitbe assumption that the same goes for the goat. Alas, it does not go.

For sixteen years the average yield of goats at agricultural shows in Britain has been declining steadily, in quantity and in quality; the goats producing it have grown bigger, giving an overall deterioration of productive efficiency of about 25 per cent since 1949, and 20 per cent since 1936. The goat breeders of 1936 were relatively innocent of cow-feeding science, and had reason to be grateful for their ignorance.

The survival of the goat in a state of domestication is primarily due to the fact that its nutritional needs are so different from those of the cow and the sheep that the goat's presence on their pastures improves the quality of the grazing. Unless we pay attention to what the nutritional needs of tbe goat are, the future of goat-breeding in

Britain is half a column on a back page of *Fur & Feather*, along with the guinea pigs and fancy rabbits.

ENERGY REQUIREMENTS

All life needs energy. Animal life needs energy to move, maintain a convenient temperature, reproduce its kind, feed its young and carry out 'running repairs' to its own organism. This energy is derived from the food the animal eats and the air it breathes. The food is the fuel and the air provides the oxygen necessary to its conversion into heat and energy. Some of the latent energy value of the food is consumed in the process of digestion.

The average amount of energy needed to maintain an animal in normal condition, without improvement or deterioration or unnecessary exertion, has been found for most kinds of farm stock. The earliest experiments were done with cattle and for some time it was assumed that the requirements of other livestock were the same as those of cattle, reduced or increased in direct proportion to body-weight. Experimental work with smaller animals demonstrated that this was not true, but that their actual requirements were approximately in proportion not to their weight but to their surface area. More exact measurement still proved that, in computing the 'maintenance energy requirements' of livestock, we have to take into account not only the larger surface area in proportion to weight that goes with diminishing size, but also the higher metabolic rate—the greater speed of all the vital processes—of smaller animals. On the basis of these latest observations a formula for maintenance energy requirements was worked out which is said to be applicable over the whole range of animal size, from whale to mouse.

The unit of food energy used in Britain and much of Europe is the net energy derived from 1 lb. of starch by a bullock—that is, the latent energy of the pound of starch, less the energy lost in the process of digestion. The energy value of samples of other feeding stuffs has been found by feeding trials mainly with cattle and sheep, and related to the energy value of starch by a figure called the starch equivalent. Thus 100 lb. of a sample of good meadow hay fed to wedder sheep was found to have the same energy value as 35 lb. of starch, and the starch equivalent of good meadow hay is said to be 35. Samples vary and so does the digestive efficiency of the animals used in the trials and the accuracy of the scientists' measurements. But these figures provide a useful guide to the energy value of feeding stuffs.

Experiments on the maintenance energy requirements of the goat have been done in America. The results agree with expectations based on the 'universal' formula already mentioned. The figure is 0·9 lb. starch equivalent per 100 lb. liveweight per day.

ENERGY FOR PRODUCTION

We want our goats not only to maintain their condition but also to produce: mainly milk but also kids and flesh and, in some cases, hair. To do so, the goat must receive a ration, in addition to her maintenance ration, and according with the kind and quantity of production expected from her.

For the past twenty years every book on goats published in Britain has stated the goat's milk production ration as 2½ lb. of starch equivalent (or 3½ lb. of balanced concentrates) per gallon of milk produced—which is precisely the ration recommended for the dairy cow. Though endorsed by the British Goat Society in their 1952 *Year Book*, this ration is inadequate for the goat.

The inadequacy of the 2½ lb. per gallon ration was demonstrated in the course of the basic work on goat nutrition and productivity by Asdell and Turner in the United States. The report of this work was published by the Department of Agriculture for the U.S.A. in 1938 (*Missouri Agricultural Experimental Station Research Bulletin 291*); copies of the report have been gathering dust on the shelves of British libraries ever since. Of the valuable store of knowledge which the report contains, the only fragment which seems to have leaked into goat-keeping circles is the fact that (mediocre) goats convert their food into milk with greater efficiency than (mediocre) cows. This fragment has leant a spurious validity to the 2½ lb. per gallon ration. In fact the goat needs fully 3 lb. of starch equivalent per gallon of milk produced.

The inadequacy of the 2½ lb. per gallon ration is further testified by the empirical advice of leading pedigree breeders and goat dairy farmers. In *Modern Dairy Goats* (1949), by J. and H. Shields, lip-service is paid to the 2½ lb. ration, but the maintenance ration there recommended includes hay, greens, silage, etc., in unspecified quantities, and 1 lb. of concentrates in addition. This would provide 1¼ lb. more starch equivalent than the largest goat in Britain could conceivably need as a maintenance ration, and would compensate for the deficiency in the production ration of a goat giving up to 2 gallons. Typical empirical advice, which works well for high-yielding

WHY THE COW RATIONING SYSTEM

WHAT HAPPENS TO 100 lbs.

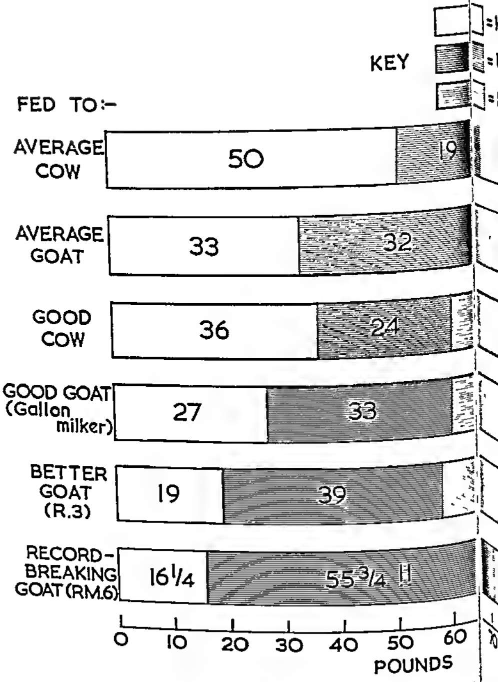
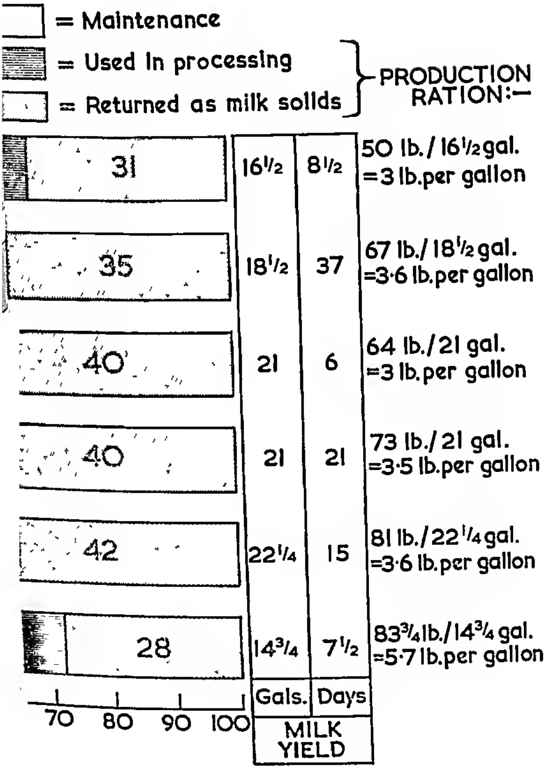


Fig. 12. After Asdell and Brody (1935), Asdell and Turner (1938).

s ty of Chicago, adapted by permission.)

UNSUITABLE FOR GOATS OR

)F DIGESTIBLE NUTRIENTS



goats such as those of the author's, and is very extravagant for lower yielding goats.

The facts of the case are displayed in Fig. 12. It will be noted that—

the goat generally produces MORE milk than the cow from the same quantity of nutrients,

the goat uses LESS food for MAINTENANCE than the cow,

the goat uses MORE food for DIGESTION AND METABOLISM than the cow.

These facts are just what plain common sense might suggest to us, without any help from the scientist. We have long known that the goat weighing about 100 lb. produced 5 lb. of milk a day with very little encouragement; and that the cow weighing about 1,000 lb. produced about 20 lb. of milk a day without exerting herself unduly. As the nutrients in the milk must come from nutrients in the food of the producer, each 100 lb. of goat must eat, chew, digest and metabolise* (i.e. turn into milk) about twice as much food a day as each 100 lb. of cow. All these processes require energy: 40 gallons of blood are pumped through the udder of the cow for each 1 lb. of milk produced. The faster they are carried out the more energy is required per lb. of food processed—as the motorist would say: 'the higher the m.p.h. the lower the m.p.g.'. So the goat needs more for processing —but as 100 lb. of goat gets through its food at twice the speed of 100 lb. of cow it requires less maintenance while disposing of a given quantity.

Three pounds of starch equivalent will provide a goat with the energy required for the making of a gallon of milk with 3·7 per cent of butter-fat. Butter-fat is a rich store of energy. If the milk contains more or less than 3·7 per cent it will require more or less energy in the making. Average goats' milk contains about 3·8 per cent of butter-fat; few goat-keepers go to the expense of having milk samples regularly tested for butter-fat; to be on the safe side the production ration for a gallon of goats' milk of unknown content should contain 3¼ lb. of starch equivalent.

PROTEIN REQUIREMENT

As well as energy in the form of starches, fats and sugars, milk, hair and flesh contain a small proportion of nitrogen compounds (pro-

* 'Metabolism' is the process of changing digested food into living matter and living matter into excretable material.

teio, etc.), and of minerals. For maintenance and production the goat's food must contain a suitahle proportion of these elements, in a suitahle form.

Animals can digest nitrogen only in the form of complicated organic compouods—true proteins. But the digestive tract of goats and other rumioants is inhahited by bacteria which cao utilize simple nitrogeo compouods such as ammonia and urea and convert them ioto true proteins. Such microhial protein is highly digestihle. The normal hreakdown of hody cells io the wear aod tear of liviog releases into the blood, aod theoce into the digestive tract, almost as much nitrogen, in the form of ammooia and urea, as the goat needs to repair the wear and tear. But the protein of flesh and milk is huilt of a numher of differeot nitrogeo compounds (amino acids), some of which the hacteria of the digestive tract are unable to construct. So a proportion of true protein is needed in the diet, even for maintenance; more, of course, is needed for growth or milk production. But quite how much is needed it is impossihle at present to say with accuracy; for we do not know either the proportion in which the various amino acids are needed to make milk and flesh, nor the proportions in which they are ohtainahle from the various foods. Furthermore, the hacteria of the digestive tract not only make protein out of ammonia and urea, hut also hreak down the proteio in the diet into ammonia and urea, attacking the protein of some foods more than that of others.

Consequently, proteio is used most ecooomically if it is offered in moderate quantities and in a variety of different forms. In practice the followiog quantities are recommended:

For Maiotenance—1 part digestible proteio to 10 parts starch equivalent.

For Growth—1 part digestihle protein to 7 parts starch equivalent.

For Milk production—0·5 lh. digestihle protein per gallon of milk.

These quantities will he found adequate if fed in the form of fresh or dry herhage, or in a mixture of protein rich cereal meals; if fed as oilcake a little more may he needed. The smell of ammooia in the goat shed in the morning, which reflects the amouot of surplus nitrogen being excreted, is a useful warniog of too much or the wrong kind of protein in the diet. If the milk yield or growth of a goat, being fed at this recommended rate, falls below expectations, it is more

effective to change the form and improve the variety of the protein foods in the diet, rather than to increase the overall amount.

To summarize the rationing standard for the goat:

For maintenance

0·9 lb. starch equivalent per 100 lb. bodyweight
0·09 lb. digestible protein per 100 lb. bodyweight

For production

3·25 lb. starch equivalent per gallon of milk
0·5 lb. digestible protein per gallon of milk.

MINERALS

While scientific standards for rationing the goat's intake of energy foods and protein are mainly useful to beginners and serve only as a rough check for the practices of experienced goat-keepers, problems arising from the goat's mineral needs afflict all manner of goats and goat-keepers, and constitute the principal difficulty of management in most high yielding herds.

Mineral needs of farm stock vary widely. The relative requirement of each type of stock depends to a slight extent on its size, to a greater extent on the relative magnitude of its digestive organs, and chiefly on the nature of its product.

Small animal systems work at a higher metabolic rate with greater wear and tear, and need more mineral maintenance. The work of digestion involves the use and loss of large quantities of minerals in the digestive juices; animals with a digestive system large in proportion to their body have large mineral needs. Eggs and milk are mineral-rich products which give their producers big mineral needs.

On all counts the goat has an outstanding mineral requirement. A small body with a high metabolic rate; a digestive system occupying at least a third of its body, and producing milk richer in minerals than the cows and greater in volume than the sheep's. Feeding adequate in minerals for other stock is liable to be deficient for the goat.

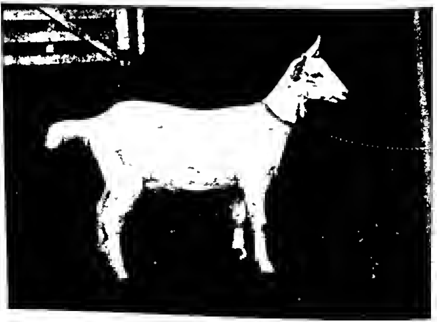
Most goat-keepers become impressed with this fact by bitter experience or much reading at an early stage in their apprenticeship. Too often they attempt to remedy the trouble by feeding a 'balanced' mineral supplement. Such mixtures usually serve a purpose at a cost out of proportion to their value to the goat. If designed to meet the requirements of dairy cattle under orthodox systems of management, the mixture will not be balanced for the goat. Even mixtures

19. Herbal lea and bramble grazing in January

20. Bitterne Tessa and RM3, Kinloch Tuath, sustain their January yields with brambles and brushwood

21. Kinloch Tuath, BT2408H. Yield 3,765 lb in 365 days, 6,382 lb. in 669 days; 7 challenge certificates at 7 shows

22. Kinloch Mhor, BT2717H, the herd sire, whose services are required once in two years, per goat. Mrs. Laing, Moorhead, Newton Stewart, Wigtownshire owns this leading Scottish pedigree herd



23. Brynteg Bush, British Saanen kid, 5 months old, is a lovely reminder that the kid-rearer's job is to build bone, not flesh. Owner and breeder, Mrs. Train

designed for dairy goats may be balanced or not for the individual goat, depending on its feeding and yield. It should be clearly understood that an excess of minerals throws a heavy strain on the goat's kidneys, which are largely responsible for getting rid of the surplus; an excess of any one mineral is liable to make another non-available; a chronic excess of many minerals deranges the working of the vital processes; some of the 'trace' minerals are acute poisons in excess.

No attempt can be made in a book of this size to deal in full with the functions and source of each of the many mineral elements necessary to the goat. The ensuing section is confined to dealing with troubles likely to arise in practice from a deficiency or excess of minerals in practical goat feeding.

Under British climatic conditions no goat, not even a wild goat giving a minimum of milk, can survive for long without access to raw salt. No selection or combination of British herbage can provide enough sodium and chlorine to meet the needs of the goat's outsize stomach and its mammary gland which secretes ¼ oz. of salt with each gallon of milk—almost 50 per cent more than in cows' milk. The only wild-goat-herds in Britain which have survived for over a century have access either to the sea-shore, rock salt or to pastures drenched by sea spray in stormy weather. Most of the domesticated goats of Britain are found in the seaboard counties. While domesticated goats in coastal regions may obtain their salt supplies in the same way, the annual salt intake of a good milker is between 15 and 20 lb. of salt a year, apart from the sodium and chlorine provided in organic combination in its normal food. This is so far in excess of its need of any other raw minerals that the provision of a supply of salt unmixed with other minerals is essential. Salt may be on offer either as a salt-lick block fixed to the wall of the house, as rock salt hung in a wire-netting bag under cover, or as rough salt in a box fixed sufficiently high to be clear of dirt and droppings.

Salt deficiency results in impaired digestion and lack of appetite. A diet of soft herbage combined with a soiled salt supply occasionally precipitates the symptoms. Anaemia resulting from lack of cobalt, or parasitic worm infestation can lower the goat's ability to retain salt and produce similar symptoms; special attention to salt supply is necessary during convalescence from these troubles.

Calcium and phosphorus are the principal components of the skeleton of the goat and essential in the chemistry of a variety of vital processes. Calcium, for instance, is concerned in blood clotting and in

the control of the metabolic rate—that is, the rate at which the vital processes are carried out—and in nervous control.

Phosphorus is needed for the release of muscular energy, for the digestion of oils and fats and for the making of new body-cells for growth, replacement or reproduction.

Calcium and phosphorus are deposited in the bone together: if the needs of the body subsequently call for either of the minerals, in quantities which the current diet cannot provide, both minerals are released from the bones together. The two minerals are always associated, yet they are always opposed in the effect which they have upon the body chemistry. A deficiency of calcium produces an opposite effect to a deficiency of phosphorus.

When there is a deficiency of calcium in the blood the goat will tend to 'overdo it'. She will eat well, yield well and be highly excitable —and then collapse.

A phosphorus deficiency may take many forms, but is always accompanied by a rather dull and apathetic attitude to life.

Calcium is a brake and phosphorus is an accelerator. In those capacities they act on the thyroid gland, which governs the metabolic rate—yield, appetite, excitability—and the rate at which calcium phosphate is withdrawn from the skeleton to serve the needs of milk production and flesh formation.

Thyroxine, the secretion of the thyroid gland, not only speeds the release of calcium phosphate, but evicts the calcium fraction from the blood-stream into the gut, from which it is excreted in the dung. Since the thyroid gland of the goat is half as big again as the cow's, and proportionately active (relative to the size of the goat, of course), goats excrete a relatively large proportion of the calcium in their diet and must have a particularly high requirement of calcium. If dietary phosphorus, combined with other factors, stimulates the thyroid unduly, calcium may be evicted from the blood faster than it can be withdrawn from the skeleton. Milk fever and tetany will then result.

If dietary calcium 'brakes' the thyroid unduly, too little calcium phosphate will be withdrawn from the skeleton to provide for the body's needs of phosphorus. Muscular stiffness, apathy, lowered yield and temporary infertility will then result—and the digestive system will be unable to absorb what phosphorus there may be in the diet.

Calcium and phosphorus deficiency disease in goats giving a good yield, or goatlings in good condition, is almost always due to an excess of one or other mineral in the diet. To produce such an excess the diet must be specialized and rather expensive.

To produce an excess of calcium there must be an overwhelming preponderance in the diet, of legumes (green or dry), sugar-heet pulp, and seaweed meal, either separately or in comhination. To produce an excess of phosphorus the diet must consist largely of cereal products, oil-cakes, young grass or young green cereals.

In all natural herhage there is sufficient calcium to halance the phosphorus content, even for the goat. But phosphorus is in chronically short supply in Nature, and for high levels of fertility and productivity must be applied to the ground, organically, in the form of hone meal, sewage sludge or fish manure, or otherwise. Symptoms of calcium deficiency are therefore 'unnatural', very severe and frequently fatal. Phosphorus deficiency in Nature is chronic and its symptoms are mild and temporary—lowered productivity heing the central theme.

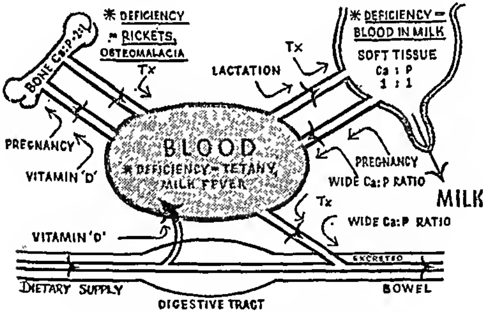


Fig. 13. Calcium balance in the goat

'Tx'—Thyroid activity—stimulated by rich sappy feeding, also by cold weather, fluctuates in sympathy with the breeding cycle (Fig. 14, p. 172). Small arrows indicate the direction of accelerating forces. For 'Wide Ca:P ratio' read 'Phosphorus rich diet'. After Owen, *British Journal of Nutrition*, 6

On exceedingly poor pastures, during their first winter, when the sunshine-generated vitamin D which is necessary for calcium phosphate ahsorption is scarce, kids may develop rickets and adults osteomalacia. Housed stock fed poor hay are more liable. Better

feeding with a bigger ration of open air, or vitamin D supplement, will cure this form of phosphorus deficiency.

Current needs for minerals for milk production do not have to be met by the diet on a day-to-day basis. The goat has a bank of calcium phosphate in its bones and can live on credit for much of the year; a well-fed, well-bred goat will do so. But the credit must be good and the bank substantial.

The goat's skeleton is laid down during its first year or two of life. It is well understood that the young animal must be adequately fed to be a successful producer later in life—rickets is rare. It is less well understood that the diet providing excess calcium or excess phosphorus, though it will produce overt symptoms only in extreme cases, is every bit as detrimental to the building of a well-mineralized skeleton as starvation would be.

Excess of calcium in the diet of young stock produces, in extreme cases, muscular stiffness in kids and goatlings during the winter. Excess phosphorus seldom produces any symptoms at all except precocity and superb condition—until the goatling kids and dies. But it has been known to give rise to summer-time rickets in goatlings grazing young corn.

The state of the mineral balance in the skeleton bank of the milking goat will be 'in the red', for the first three or four months of lactation; as yield falls it will be recouped gradually from current diet. This is not possible if rationing to yield is practised in the standard mechanical dairy cow way.

Magnesium in small quantities is required in the diet, bone and blood of the goat, where it is a necessary companion and assistant to calcium in the chemistry of the body. At least some of the functions of calcium cannot be performed without the presence of magnesium; when the magnesium content of grass—which rises and falls in a seasonal cycle—falls to its lowest levels in May and November, grass-fed goats are liable to tetany. Apart from this trouble, which can be avoided by feeding a bulky alternative to grass or a magnesium supplement at these seasons, lack of magnesium gives rise to little ill health, in practice.

Iodine. The thyroid gland which controls the metabolic rate of goats and other higher animals needs a supply of iodine with which to manufacture its secretion—thyroxine.

If the supply of iodine runs short of requirements, the thyroid gland increases in size to make the most of small resources and a

goitre is produced. But the goitre is an unreliable symptom and the least important consequence of iodine deficiency, which can cause a great deal of loss and ill health without any visible or tangible increase in the size of the thyroid gland (which is sited in the throat).

Iodine deficiency produces its own characteristic symptoms, harsh dry hair, dead parchment-like skin, still-born (often hairless) kids. Dead female kids born with live male kids are especially symptomatic of a slight but dangerous deficiency—or female kids which die soon after birth, along with male kids that thrive—for the female has a bigger thyroid and iodine need.

Deficient secretion of thyroxine, which is a normal consequence of iodine deficiency, but may be due to other causes too (e.g. poor feeding or a diseased gland), results in lowered vitality and productivity and poor udder development in first kidders. Since thyroxine is required to release calcium phosphate from the skeleton, deficient secretion may also produce symptoms of phosphorus deficiency.

Recent research has shown that the animal's ability to assimilate vitamin A and carotene depends on its thyroid activity. So iodine deficiency bears in its train the consequences of vitamin A deficiency as well—retarded growth, infertility and low resistance to infection.

The goat has a thyroid gland which, in proportion to bodyweight, is half as big again as that of the cow. It has a correspondingly higher requirement of iodine. The more productive the goat the greater her need for iodine.

Because calcium acts as a brake upon the effect of thyroxine in the blood, excess of calcium in the diet calls for additional supplies of iodine to rectify the balance.

The goat's iodine needs are further enhanced if she is fed cabbage or kale which, especially in hot seasons, contain a substance which acts, like calcium, in opposition to thyroxine.

Iodine differs from all the other minerals in that its presence in vegetation is very little related to the species of plant and almost entirely to the amount of iodine available in the soil. Being highly soluble, iodine is richest in the sea and in districts swept by sea spray: it is rich too on soils that hold their moisture well, peats, clays and humus-rich land. It is easily washed out of thin soils, sands, gravels, limestones—and the more water there is to wash it away—from rainfall or fresh-water flooding—the quicker it goes.

Lime blocks the uptake of iodine from the soil, as it suppresses the

effect of thyroxine in the blood. Over-liming produces crops which give rise to an iodine deficiency in the consumer.

Heavy applications of artificial manures and continued cash cropping reduce the iodine content of the soil by lowering its water-holding properties.

Despite the large potential demands for iodine made by the dairy goat, and the varied circumstances in which the soil may be deficient, the actual quantity of iodine required is very small. The application of 1½ cwt. per acre of Chilean nitrate of soda will provide the nitrogenous manuring along with all the iodine needed by goats consuming the crop: 1½ cwt. per acre of seaweed meal of fertilizer grade will provide the iodine without inorganic nitrogen.

Copper is needed by the goat in minute quantities to aid in the digestion and use of iron in the body. The need is met under most British conditions. In Australia and New Zealand there are wide areas with an absolute deficiency of copper in the soil. In Britain there are a few notorious districts where the copper in the soil is rendered unavailable to plants by the presence of excess molybdenum —these are the 'teart' and 'sway-back' areas. But most peat-land is rich in molybdenum: if heavily limed the molybdenum becomes available to plants and the uptake of copper is blocked. Basic slag, which contains molybdenum as well as lime, creates the effect more readily. In the reclamation of peat-land this can be a serious consideration, as the Irish have already learnt at some cost.

In the face of available molybdenum it is useless to add copper to the soil and a copper supplement fed to the goat is the only cure in bad 'teart' districts.

The symptoms of copper deficiency are scours, staring coat, and loss of pigment from the hair, giving the coat a washed-out appearance. The home-made supplement is 1 oz. copper sulphate dissolved in a pint of water, to be poured over 6½ lb. salt; evaporate the surplus moisture and when dry add 1½ lb. red oxide of iron. Goats may have free access to this mixture.

Cobalt is needed by the ruminant to provide the bacteria of its digestive tract with the raw material from which to synthesize vitamin B_{12}. This vitamin is the antidote to pernicious anaemia, lack of it causes this disease, and encourages acetonaemia—possibly other diseases as well—research workers are busy on the subject. Some, if not all, internal parasites rob their host of this vitamin as it enters the body from the digestive tract.

The sheep has greater need of cobalt than the cow and the goat

appears to have a cobalt requirement four times as great as the sheep's. Since the goat has a daily intake capacity for dry matter at least twice as great as the sbeep, the goat would prohably be satisfied with a concentration of cobalt in the herhage only twice as great as that which is adequate for the sbeep.

There is little consolation in this thougbt, for the mapping of the areas which are cohalt deficient for sheep is still in progress and already includes great streches of country in tbe west of Scotland and the south-west counties of England. Moreover, lime depresses the uptake of cobalt, and the lime-rich legumes beloved of goat-keepers require lime-rich soils to grow on. Cohalt is a requirement few goat-keepers can afford to forget.

The proportion of cohalt included in commercial trace-element mixtures has repeatedly heen proved wortbless for deficient goats. Dissolve 1 oz. of cobalt sulphate in ½ pint of water; wet 6 lb. of salt with the solution; dry and allow free access. Anaemia consequent on worm infestation, or acetonaemia tbat accompanies a low fibre diet, or bitter tasting milk witb a low butter-fat content, can best be treated as a temporary lack of cohalt and countered by adding 1 oz. of tbe above mixture to tbe concentrates eacb day for a week. Chronic deficiency due to sbeer lack of cobalt is evidenced by a gradual loss of appetite, wasting and sensitivity to cold; as soon as possible tbe goat grazings sbould be treated witb 2 lb. cobalt sulphate to tbe acre; this may he applied mixed with superphospbate or sand. Many fertilizer firms now supply 'cohaltized' superpbosphate; or the mixing may be done on the farm in a concrete mixer, or in a treacle harrel, bolted to tbe jacked-up wheel of a tractor.

Once a deficiency of cobalt is suspected the diagnosis is easy. Unless there is a dramatic response to tbe cohalt supplement, prescribed above, within a fortnigbt, tbere is no deficiency; unless there is also a heavy worm infestation, the response will occur within tbree or four days, or not at all.

Cobalt applied to peat land may have an effect similar to that of lime, hy releasing latent molybdenum and blocking tbe uptake of copper. But heather, that tbrives on peat, is efficient at concentrating the available cobalt, and goats on heather grazing are less likely to suffer deficiency.

Mineral supplements. We may cater for the mineral needs of the goat in three ways: by treatment of the soil on whicb we grow tbe goat food, by selection of the species of plant we grow for goat food, by feeding a concentrated mineral mixture.

The effects we can achieve by treatment of the soil are severely limited. Though most applications are reflected to some extent in the mineral composition of the crnp, some minerals are taken up far more readily than others, and the mineral cnntent of the crop is determined more by the typical mineral content of the plant species than by the mineral state of the soil.

Application tn the soil nf phosphates is generally eonsidered necessary tn an economic level nf productivity frnm the land and is markedly reflected in the phnsphate content nf most species of plants grown nn treated snil. Snil treatment is alsn the most effective and least costly method nf curing iodine deficiencies, except perhaps nn chalk soils.

Cobalt and magnesium (in the form of magnesian lime) can he applied to the soil to treat a specifie lack. In some cases nf eohalt deficiency, and in all cases of magnesium deficiency, the selection of suitahle crop plants will have as good effect, or hetter.

Soil treatment is unlikely to cure animal deficiencies in lime, sodium, ehlorine, potassium or eopper.

It is not intended to offer an opinion on the relative merits of organic and inorganie manures. But, except in so far as methods which maintain the humus eontent assist the retention of all the available minerals—especially iodine—the normal run of balanced artificial fertilizers have an effect on the mineral content of the crop which in nn significant way differs from that produced hy applications of farmyard manure. Farmyard manure increases the eopper content of crops ahove normal levels, hut only hecause most animal feeding already contains more cnpper than required, and dung is rich in the surplus. Basic slag, hnwever, is not a halanced artificial: it has a remarkahle effect in blocking the uptake of trace elements by most crop species, and should be used most warily on land where trace-element deficiencies are suspected. Whatever method nf improving land fertility is used, nrganic or inorganic, if effective, it will raise the available calcium content of the snil, and so lower the content of cobalt in the crops. This fact constitutes a recommendation to feed goats, at least partly, nn the produce of uncultivated land. This recommendation seems more relevant than any consideration of the rival merits of organic and inorganic manuring—if the merits are, in fact, rival.

To say that treatment of the soil cannot provide a solution to the mineral needs of the goat is to state a happy fact in a distorted and depressing way. The happy fact is that the mineral needs of the goat

can be met under an immense range of soil conditions; goats, domesticated and wild, can thrive over a far wider territory than either sheep or cattle.

Sheep and cattle are tied to the more concentrated nutrients of grass by their relatively low food intake capacity. The large appetite of the goat frees it from this bondage, and permits use of all manner of plants other than grass, even those which have a lower concentration of nutrients. The grasses are, minerally speaking, the most poverty-stricken family in the vegetable world.

To the traditional farmer, pasture is grass. During the past fifty years he has conceded a place to clover as a low cost grass fertilizer, and a supplier of minerals to more efficient cows. During the past twenty years he has learnt to use lucerne for high yielders, and has heard mention of 'herbs' in the pasture, as an aid to cows whose mineral needs approximate ever more closely to those of the goat as their productive efficiency increases.

'Herbs' is a most unfortunate term, which botanically means everything and nothing. In 'herbs' our great-aunt dabbled benignly and nasty old village spinsters dabbled wickedly. 'Herbs' is the clan cry of the neurotic back-to-nature girls. Herbs have a proper place in the kitchen garden, soups and duck stuffing, but not—the farmer feels—in stock rations and field crops.

For centuries we have been feeding our sheep and cattle on a mixture of grass, legumes, and miscellaneous fodder plants, including weeds such as daisy, buttercup and nettle, acceptable meadow species like plantain and yarrow, and cultivated pasture plants like chicory and burnet. During all of that time every farmer who wasn't stone blind knew his stock ate most of them and liked them. Until relatively recently he maintained these species on his fields by sowing out with barn sweepings. Since the introduction of pedigree seeds mixtures, the average annual hay crop has shown no significant increase, the sale of mineral mixtures for stock-feeding has risen from near zero to over 40,000 tons per annum, and mineral deficiency disease has become a major farm problem. The effect of replacing these miscellaneous pasture plants by grass and clover is to reduce the mineral content of the sward by approximately 20 per cent.

Clovers held a place in the pasture no more honourable than that of the plantain until it became known that clover increased the fertility of the soil. Subsequent study of the legumes proved them to have a high mineral content, and goat-keepers have come to regard clover and its fellow legumes as a necessary goat food. In reality, the

common plantain is not only richer in minerals than any legume, but its mineral content is better digested by stock; as a crop plant, plantain can produce more carbohydrates and protein per acre than clover. Lucerne yields a good bulk of the major nutrients and is rich in calcium and phosphorus, but there is not one weed of the fields which cannot put its cobalt content to shame.

In pinning our faith to legumes we make the chronic twentieth-century error of blinding ourselves with scraps of science. No one species of plant is good at everything, or there would not be such a variety of plants in existence.

The legumes are expert at fixing atmospheric nitrogen as plant food; but they are most demanding and inefficient in other ways. They must have lime and phosphorus and humus in plenty at their root-tips to exist at all; much of the carbohydrate that they fix goes to feed their nodule bacteria, and their content of the major nutrients is either small in comparison with the space they occupy or accompanied by a high percentage of fibre.

Some grass or other can be relied on to cover almost any patch of bare soil with a protective mat and a modicum of organic matter. But grasses are very inefficient at gathering minerals.

Of the other fodder plants of pasture, some, like the plantain and nettle, are miraculously efficient at foraging for minerals near the surface of humus, especially bare humus. Others, like the dandelion and chicory, excel at salvaging from the subsoil minerals that have been washed beyond the horizon of shallow-rooted plants. Such contemptible species as buttercup and yellow rattle keep minerals in circulation on the surface of water-logged pastures. On hard acid ground sheep sorrel hunts up lime. In the natural pasture each of these species in its own way deliver minerals at the feet of the nitrogen-fixing clovers and at the feet of the grasses which form the protective mat. Such is the natural economy of pasture.

From the foregoing paragraph the goat-keeper is intended to garner two notions—that the other fodder plants of pasture (the 'weeds') are by their nature, and in general superior in mineral content to both grasses and clovers. This will be easily acceptable by experienced goat-keepers. That the presence of weeds in a pasture increases its general productivity and well-being is a notion that smacks of nonsense. But it is true, and can be seen to be true if we get over the inevitable misunderstanding.

With time and use a pasture grows weedy and its productivity decreases; so we plough it up, put the land through a rotation of

crops and manuring and reseed it to a more productive pasture. The increase in weed content is a certain symptom of lowered productivity; but it is not the cause. The cause is our failure to replace the plant foods and minerals which our use of the pasture and the leaching effect of rain remove. In the weakened turf there is room and need for increasing numbers of weeds to provide the deficiencies. But if, after ploughing and putting through a rotation, we reseed with grass, clover and 'other fodder plants' suitable to the soil, the productivity of the sward will be higher than if we omit the 'other fodder plants', and deterioration will be slower.

No special inspiration or insight into the Workings of Nature is needed to reach these conclusions. Brynmor Thomas and fellow research workers at the Durham University School of Agriculture have investigated accurately the earlier suggestions of R. H. Elliott and Stapledon. Here are the facts concerning one of their trial fields at Cockle Park.

The percentage composition of the herbage from swards containing varying percentages of other fodder plants

Constituent	*Standard Grass and Clover Mixture*	*With 10 per cent Other Fodder Plants**	*With 50 per cent Other Fodder Plants*	*With 100 per cent Other Fodder Plants*
Crude protein	16·75	17·19	16·90	16·94
Crude fibre	21·32	19·49	18·61	15·16
Total ash (silica free)	10·18	11·07	13·01	14·83
Calcium	1·15	1·36	1·60	2·16
Phosphorus	0·29	0·36	0·38	0·41
Magnesium (MgO)	0·42	0·45	0·48	0·52
Sodium (Na_2O)	0·08	0·11	0·14	0·18
Chlorine	0·26	0·30	0·37	0·48

It will be noted that the statement that the removal of 'weeds' from our pastures 'lowered their mineral content by 20 per cent' is somewhat charitable to the agricultural advisers responsible.

There is a difference between weeds and 'other fodder plants' in that though weeds are all mineral-efficient, some weeds are not fodder for any beast, and their presence in the pasture reduces productivity accordingly. A list of some fodder plants of pasture, with their con-

* Later experiments suggest that 7 per cent of Other Fodder Plants produces the optimum yield of major nutrients.

tent of major nutrients and minerals is to be found in Appendix 3. The intelligent use of this list will provide all the mineral supplements needed in most districts, for goat-keepers who grow most of their own goat food—with the probable exception of salt.

Some of the fodder plants, such as chicory and plantain can be grown economically as row-crops—but in feeding remember that plantain is laxative. Nettles can be grown as a rotational row crop on a garden scale if the roots are set in bottomless buckets or oil-drums sunk in the soil; they are best used for hay. A permanent field crop of nettles for silage and hay is a long overdue agricultural experiment. In general the fodder plants are best sown where they belong—broadcast in a composite pasture. To maintain the pasture's content of fodder plants it is preferable that the field be grazed by cattle or horses as well as by the selective goat.

The provision of fodder plant hay and pasture is particularly imperative for the owners of high-yielding goats which show a liability to milk tetany in April-May, and to miscellaneous breeding and metabolism troubles in the autumn. The autumn troubles are due to high calcium phosphorus deficiency, brought about by the introduction of legume or orthodox meadow hay into the diet—hay-making increases the proportion of calcium to phosphorus. Tetany is due to magnesium deficiency and the following table is self-explanatory.

Magnesium content of swards with and without other fodder plants at various stages of the grazing season

	May	*June*	*July*	*Aug.*	*Sept.*
Grass and clover only	0·35	0·39	0·46	0·47	0·45
With 10 per cent other fodder plants	0·39	0·43	0·51	0·51	0·47
With 50 per cent other fodder plants	0·47	0·46	0·52	0·53	0·51
With 100 per cent fodder plants	0·53	0·48	0·61	0·53	0·54

The owners of not-so-high-yielding goats on thin permeable soils are, in practice, less bothered with mineral deficiency troubles when they grow most of their own goat food, because they are incapable of providing an excess of any mineral in the pasture. Only at great expense can they raise the mineral status of the soil to a level at which weeds can be effectively excluded from the sward. Well-made

weedy hay from poor meadows has a better balance of minerals than seeds hay from fertile grouod.

No ooe cares to test new notions on their valued stock. The suggestions of this section are ioevitably rather novel because the scientific work on which they are founded is recent, and dairy cattle farmers have not such hig mineral needs to cater for as goat-keepers have. But the basic idea that the 'herhs' or other fodder plants have an importaot place in the pasture and diet of the dairy animal is older thao any of us, and has received practical confirmatioo in recent times at the hands of the Clifden Park system of farming and more recently still at the haods of the 'organic' school. All that is new here is the exact guidance to the value of iodividual weeds, and the scientific backing to empirical methods.

Before passing to the alternative method of supplementing mineral requirements by feeding concentrated mineral mixtures, it must be emphasized that the more we investigate mioeral deficiency troubles in goats the more we find them due to excess of another mineral rather than absolute deficiency. Intelligent as goats are, their brilliance does not reach to the ability to make, with one soiff and lick, a chemical analysis of a complicated mineral mixture, aod to ration themselves accordiogly. That animal iostinct in mioeral feeding is highly erratic has been proved in this country aod others on a number of occasions. Human skill in mineral feeding is often limited by lack of knowledge of the mixture fed and the needs of the stock who receive it.

Mineral mixtures will ooly he required when high levels of feediog are practised and the diet is unhalanced in minerals, or on the poorest pastures. The standard close-ratio mineral mixture is suitable for low levels of nutritioo. On high levels of feediog, the mineral halance is usually delicate and tbe symptoms of deficieocy lack clarity. Provided the goat-keeper knows tbe approximate compositioo of the mixture he is feeding, and has gathered some understanding of the mechanism of mineral balance in the goat, he has a fair chance of juggling successfully with a selection of mixtures. His cbances of success are clouded hy feediog any coosiderable quantity of mineralized compouod cake, wbich introduces a big unknown factor into the reckoning. The best that can be dooe here is to consider the broad categories of trouhle.

(1) *The High Calcium Diet* consists almost entirely of high-quality fodder crops, clover, lucerne, oats and tares, kale, comfrey, etc., witb perhaps a more or less generous allowaoce of sugar-beet pulp aod

2 or 3 lb. of concentrates. The danger here is twofold. The wealth of calcium may block the uptake of phosphorus from the diet; excess calcium in the blood may 'brake' the effect of thyroxine, preventing the release of skeletal phosphorus, and putting a strain on resources of iodine. Symptoms are most likely to arise with the introduction of winter feeding legume hay, etc., and take the form of lowered production and miscellaneous breeding troubles.

If the deficiency is a dual one of iodine and phosphorus there will be a response to seaweed meal, which is rich in iodine; yields will improve with this treatment, but as seaweed meal is poor in phosphorus and very rich in lime the phosphorus deficiency will become more acute and breeding troubles more accentuated. For this reason seaweed meal should never be used in conjunction with a diet of this type.

A standard close-ratio iodized dairy mixture will meet requirements. A cheaper home-made substitute is 10 lb. salt, 5 lb. steamed bone flour, with ½ oz. potassium iodide dissolved in a little water and sprayed over the dry minerals spread in a tray. Some goats refuse bone-meal mixtures; for these faddists a teaspoon of calcium phosphate syrup* a day, and a tablespoon of stock iodide solution (½ oz. potassium iodide in 3 pints water), mixed with food or drinking-water or administered by dosing.

(2) *High Phosphote Diet.* This may consist of more than 2 lb. per day of cereals and oil cake in a ration which either does not exceed 6 lb. of dry matter altogether, or does not include at least 3 lb. of legume hay or its equivalent in green legumes. The diet is often met with under circumstances where bulky food of good quality is scarce; the symptoms are precipitated most often in early spring, when the goat is being brought into milk on inadequate roughages; milk fever and tetany are serious consequences; nervous excitement and blood in the milk are warnings.

Goats so fed have a great appetite for seaweed meal in many cases; allowed free access they may consume so much that a phosphorus deficiency results. They should be limited to 6 oz. of seaweed meal per day, which is as good a supplement as any for a diet of this type. Standard dairy salts are of little use.

Calcium phosphate syrup and a vitamin D supplement can be administered to goats who do not take well to seaweed meal. The mixture is a valuable one because it is well digested and can swamp excess of either calcium or phosphorus in the blood by its correct

* Strictly speaking, 'calcium lacto-phosphate'.

proportions. But the inclusion of vitamin D constitutes a hrake upon the effect of thyroxine and may give rise to iodine deficiency. The use of calcium phospbate vitamin D mixture on goats in late pregnancy bas heen associated with symptoms of pregnancy toxaemia—ahortion and muscular collapse.

Let no newcomer to goats he in the least alarmed hy tbese complications in feeding mineral mixtures. Correctly fed goats do not nced them at all; very high yields can be maintained without them; even overfat condition along with high yields is possible without indulging in this jugglery. The mineral mixtures are only necessary where a goat-keeper who cannot grow or obtain suitahle bulk foods wishes to enter the ranks of pedigree hreeders and sbowmen. For moderate yields good meadow hays and ordinary grazing, or even hill grazing, are quite adequate. For the highest yields without mineral mixtures it is necessary to feed the goat mainly on high-quality hulk foods incorporating a halanced variety of hroad-leaved fodder plants, and not only legumes. Chicory appears to he the only plant which can hy itself meet all the goat's needs of major and minor nutrients and minerals and produce an economic bulk of fodder from cultivated land.

VITAMINS

No subject hetter illustrates the change of balance in tbe science of animal husbandry which is taking place tban a study of vitamins. The ever-deepening knowledge of the normal and natural chemistry of tbe animal body is continually adding to the list of essential nutrients new 'vitamins', substances whose presence in small amounts is essential to health. The identification of each new vitamin replaces a chemical drug, a surgeon's knife or a pathological frustration by a natural foodstuff.

It is normal practice to classify the vitamins into the fat-soluble (A, D, E, and K) and water-soluble (all the rest) groups. This serves no useful purpose to the farmer and is a fruitful source of popular error, and inaccurate advertisements of vitamins A and D as synonymous 'sunshine vitamins'.

Vitamin A has nothing to do with sunshine and is a colourless substance whose importance to nnimal life lies mainly in fortifying the body's outer defences of skin nnd mucous membranc against infection and keeping them in good condition. Its deficiency gives rise to disease of the mucous membranes, particularly that of the

eyes, causing night-blindness and soreness, and to a higher susceptibility to infection. It is equally important to man and goat.

The natural sources of the vitamin for the goat are the carotenoid pigments associated with the green colouring matter of plant leaves and the yellow colouring matter of carrots, roots and yellow maize. Carotenoids are absorbed from the digestive tract, and converted into vitamin A in the animal body. The conversion of carotene into vitamin A depends on the activity of the thyroid gland; goats have a thyroid gland half as big again, in proportion to their size, as that of a cow, and they are exceptionally efficient in converting carotenoids into vitamin A.

During the summer months when green herbage rich in carotene abounds, both goat and cow store a reserve in the liver. In winter, when natural supplies of carotene are scarce, part of these reserves are expended in current use. But a certain proportion remains in the liver to be released, when the goat kids, into the colostrum and first milk.

While winter supplies of carotene are poor, a maintenance allowance is to be found in well-cured hay and silage, while kale and carrots in the diet will help to maintain the vitamin quality of the milk. Seaweed meal made from fresh Ascophyllum has a useful carotene content and yellow maize is the richest source among concentrates. Some attention to the goat's carotene supplies in winter is well rewarded as they will digest it more efficiently than the cow, and pass it on in the milk when the human consumer thereof is in most need. If available food will not supply it, a vitamin supplement, such as that sold by Boots and Cooper MacDougall, will serve equally well. Cod liver oil is not recommended as a source of vitamin A for goats in normal circumstances.

Vitamin-A deficiency in goats should not arise under normally good management. But goats are subject to infestation with two kinds of internal parasites that may affect their vitamin-A reserve. Liver fluke is common among goats sharing water-logged pastures with sheep and cattle, and where sheep or cattle are subject to antifluke dosing, goats should be included in the routine—the standard sheep dose of hexachlorethane being suitable. Such treatment should be followed up with a vitamin-A supplement, preferably of the dry type. Coccidiosis produces violent symptoms in goats on close-cropped pastures. Infection is confined to warm damp weather and is commonest in early summer. Coccidia block the uptake of carotenoids from the intestine and the use of a vitamin-A supplement speeds convalescence.

Vitamin B is a complex composed of a number of substances soluble in water, required in varying proportions by different animals. Men, pigs and poultry suffer most from deficiencies. The goat, along with other ruminants, is blessed with bacteria that synthesize most of the vitamins from constituents of foodstuffs in the digestive tract, and is largely independent of a dietary supply of the vitamins. However the process may be thrown out of gear by several possible misfortunes. There may be a shortage of the necessary constituents in the goat's food—a lack of cobalt, for instance, may prevent the synthesis of B_{12}. The food may contain substances which inhibit the synthesis of the vitamin—some cereals and pulses have this effect. Certain types of diet, particularly diets low in fibre, may discourage the proliferation of the bacteria responsible for vitamin synthesis. Parasitic worms may grab the vitamins after the bacteria have synthesized them and before they are absorbed into the body of the animal. Apart from dangers arising from lack of cobalt, which have already been dealt with, the vigorous persistency with which the bacteria carry out their task will overcome any handicaps to the process which are likely to afflict a reasonably well-tended goat. Nevertheless, a goat reduced to poor and shabby condition by persistent worm infestations or prolonged digestive troubles will benefit from access to a vitamin-B supplement. This may be provided in the form of bran mash, wheat-germ meal, yeast, yeast extracts, or proprietary vitamin concentrate. Seaweed meal is a useful medium level source of supply suitable for regular use to prevent deficiency arising.

Vitamin C is not required in the diet of ruminants, though it is usually present in large quantities. The goat makes vitamin C out of the constituents of the blood. No deficiency of vitamin C in goats has ever been reported and only rare cases occur among cattle.

Vitamin D is necessary for the absorption into the body of calcium and phosphorus and for their deposition in the bones. Along with calcium, vitamin D acts as a check on the action of thyroxine and a control of the metabolic rate and the rate of demineralization of the skeleton during lactation. The goat's requirement of vitamin D is not fixed, but varies with its feeding and phosphorus intake. A goat on a low level of nutrition will build a sound skeleton and keep free of milk fever, tetany and osteomalacia under a very much smaller intake of vitamin D than that needed by a well-bred, well-fed goat. In breeding for high milk yields we automatically breed for higher thyroid activity and larger vitamin-D requirement.

The main source of vitamin D for goats is the action of sunlight

From	France (Crépin's *La Chèvre*)	7 lb. per 100 lb. weight
	Italy (Giulani on Maltese goats)	5 lb. per 100 lb. weight
	Germany (Uhlrich)	over 5 lb. per 100 lb. weight
	Britain (*B.G.S. Year Book* '52):	
	Minimum	5 lb. per 100 lb. weight
	Gallon milker	6·5 lb. per 100 lb. weight

In the American experiments on goat nutrition mentioned above the goats were fed *ad lib.* and no attempt was made to assess their food capacity as such. But their food intake (of a rather concentrated and monotonous diet) was recorded, and so were their bodyweights. Thanks to Professor Asdell, who provided me with unpublished information regarding the diet on which the goats were fed, the following figures can be given:

Seven goats over six months consumed on the average 5·15 lb. dry matter per 100 lb. bodyweight per day.

Seven goats during the week of minimum food consumption ate on the average 4·7 lb. dry matter per 100 lb. bodyweight per day.

Seven goats during the week of maximum food consumption ate on the average 6·3 lb. dry matter per 100 lb. bodyweight per day.

The hungriest goat during the week of maximum consumption ate 8 lb. dry matter per 100 lb. bodyweight per day.

Further confirmation of the exceptionally large appetite of the goat can be obtained merely by glancing at the yields of officially recorded goats and relating them to the efficiency with which goats have been shown to convert food to milk. A gallon of milk represents between 3·3 lb. and 4·5 lb. of *starch equivalent* in food intake—that is, from 6 to 9 lb. of normal dry feeding—and many goats give between 1½ and 2 gallons of milk a day for long periods.

It seems fair to state that the minimum appetite of the goat is about 5 lb. of dry matter per 100 lb. of bodyweight, and that well-bred, productive goats can extend their intake capacity to over 8 per cent of bodyweight.

The economic importance of exploiting the goat's appetite to the full is obvious. Even a high-yielding goat can obtain almost the whole of her food requirements from natural herbage during a great part of the year. To illustrate the point the following table shows how a goat, giving a gallon of milk a day, can meet her minimum requirements of phosphorus on different types of grazing. Phosphorus is a good indicator of the presence of other essential nutrients

on a substance in the skin. Even during winter-time normal exposure to sky-shine (not even wintry sun) will provide more vitamin D than can be found in the natural diet. For goats on a moderate diet with a moderate yield we need look no further than the open air for vitamin-D supplies. The high-yielding goat, especially in winter-time, needs special attention.

Vitamin D is found in herbage in small quantities, being formed by the action of sunlight on plant substances. The concentration is not great, but the process of hay-making increases it and theoretically 4 lb. a day of good hay, preferably clover hay, should provide ample vitamin-D supplies to any goat. In practice it often fails to do so, as instanced by tetany and milk fever. For hay also contains a substance that counteracts the effect of vitamin D. For well-fed goats, be they growing or milking a winter-time supplement of vitamin D is advisable as a safety measure—and with very high yielders such a supplement may be continued into the summer with advantage. Cod liver oil is not advised for a variety of reasons; it is indigestible, unpalatable, and even a small quantity causes big fluctuations in milk yield and butter-fat. Combined with typical winter feeding rations cod liver oil is capable of producing vitamin-E deficiency symptoms (muscular degeneration) in all ruminants; in goats it appears to be the only method of inducing a deficiency of vitamin E.

Dry vitamin-D concentrates are obtainable mixed with other dry vitamins, or on their own. Seaweed meal has a moderate vitamin-D content and is suitable for regular use mixed in the feed of high-yielding goats at the rate of about 1 oz. per lb. of concentrates.

Vitamin E is somewhat enigmatic in its functions: a deficiency causes infertility in rats, fatty degeneration of the muscles of calves, heart failure in cows and muscular degeneration in sheep and goats. Deficiency is easy to produce in rats, is a troublesome disease of calves and can be produced in full-grown ruminants only with great difficulty and cod liver oil. For the practical goat-keeper it has interest in only one connection. Where goats are used for calf-rearing, the readiness with which a dietary supply of vitamin E is passed by the goat into its milk, can save the calves from the need for vitamin-E supplement. The dietary supply to the goat may take the form of bran or wheat-germ meal. Such calves should have a dry vitamin-D supplement and not cod liver oil. The trace-element selenium appears to bear the same relation to vitamin E as cobalt does to vitamin B_{12}. Selenium supplements may replace vitamin-E supplements.

Erstwhile vitamins G and H have been relegated to the B complex.

Vitamin K is concerned with the clotting of the blood; all ruminants are adequately supplied on farm diets; a deficiency is rarely reported among cattle; a deficiency in goats would be a collector's piece.

APPETITE

Until we know what weight or bulk of food a goat will eat in the day, we cannot tell in what form the pounds of starch equivalent and digestible protein of the scientific ration should be offered. Without some kind of standard for the goat's appetite no scientific rationing system can be practised.

In fact, no such standard exists. No scientific rationing of goats has ever been practised; every experienced goat-keeper has his own empirical methods of feeding; the literature of the subject is rich in whimsy, quackery and vagueness.

When a scientific worker, inexperienced in goat feeding, is called upon to feed goats in the course of his experiments, he looks for the vital information regarding the goat's appetite and nutritional needs in the international reference work, Morrison's *Feeds & Feeding* (or in Hansson's *Animal Feeding* if he is a Spaniard or Scandinavian). Morrison's *Feeds & Feeding* devotes half of one page to the goat in a 1,200-page book. The sample ration given (presumably for an average goat of about 100 lb. weight) allows the goat 3½ lb. of dry matter a day. Hansson allows the goat 2 lb. dry matter per 100 lb. weight each day, as a minimum. A leading British scientist, who used the more generous Morrison formula, writes to me from one of our research institutes as follows: 'When we first started keeping goats we had no provision for isolating them from one another in separate stalls and occasionally a goat would break away from its chain and eat the meal of another goat after having finished its own. This meal being dry caused an acute impactation of the rumen. Such impactation caused the death of three goats when we first started keeping them . . . this happened twice again but we saved these latter two animals by giving a spoonful of kerosene. . . .' A ration which necessitates goats being kept strictly isolated from one another, under pain of death, is unsatisfactory!

Writers on goat-keeping produce a fair number of sample diets; if you happen to have at hand the particular combination of foodstuffs recommended, such diets are useful; if not, not. But at least one can calculate from them the quantity of dry matter per day recommended by practical goat-keepers. The results are illuminating:

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will favour the dominance of disease-producing bacteria such as those associated with entero-toxaemia.

Appetite, however, varies between different breeds of goat. The survival of wild goats in places where the vegetation is too coarse and sparse to maintain any other grazing beast is an indication that a large appetite is characteristic of the species. But goats have long been domesticated and this character has been modified along with others.

Breeds of goats developed under cold conditions have automatically been developed with large appetites. Low temperatures during early life stimulate more vigorous heart action which results in the development of wide-sprung ribs. Low temperatures later in life guide the chilly goat to consume the maximum of fibre, for heat. The contrast between the wide-sprung ribs of the Swiss breeds and the flat-sided appearance of the notable dairy breeds from hot countries is self-explanatory.

If it is desired for economic reasons to feed a concentrated ration —as it well may be in order to cut the labour costs of stall-feeding— then a goat of suitable breed type must be chosen. They are not easy to find in Britain, but flat-sided Anglo-Nubians and goats showing signs of Maltese blood in their appearance do exist.

PALATABILITY

There is little in the way of green vegetation that the goat will not eat. Its taste is more catholic than that of other grazing stock; its diet includes about 15 per cent more species of plants than the cow's or sheep's. Spines, thorns and bristles are seldom deterrent; stinging nettles are popular and even the most tender-mouthed kid will engulf the fully armoured head of a spear thistle with pleasure.

Favourite trees are elm, ash, hazel, willow and oak.

Favourite shrubs are brambles, briars, ivy, gorse and ling heather.

Most favoured among common weeds are bog-weed, thistles, seeding stinging nettles, plantain, cleavers and docks.

The best of the classic forage crops for goats are maize, mashlum, rape and kale; less usual but well liked are sweet blue lupin, artichokes, chicory and comfrey.

Among the roots the potato takes first place, with mangolds and sugar beet second. Swedes and turnips are almost 90 per cent cold water; in winter-time only goats on a very fibrous (and therefore warming) diet will eat them regularly in quantity.

Of hays goats prefer the leafy and well cured. As tbey are ahle to pick out fragments answering to this description from an inferior mass they do so, and waste in tbe process most of the inferior mass and a great deal of tbe hest leaf. Clover and lucerne hay is liked by goats and widely used by goat-keepers; but it is expensive to huy and impossible to grow in many districts; the leaf is excessively fragile and the stem often excessively tough. Hay made from a leafy cocksfoot and clover mixture is perbaps tbe most economical feed; tbe tough, easily cured cocksfoot leaf encloses the fragile clover in an inextricable tangle and feeding losses are low. But any really leafy hay will suffice. Hays made from the classic meadow grasses all tend to be minerally deficient for and relatively unattractive to tbe goat. Hay made on a weed patch with the maximum of nettles and docks is always preferahle. Dried branches, pure nettle hay, and dried comfrey leaves are luxuries for which only the minority of goat-keepers can find the time, space and sunsbine.

In hygone days gorse was harvested as hay for goats and horses and ground in whin mills for cattle. The mill, which exercised the hull as well as the horses, consisted of a 6-ft.-long truncated cone of granite, which was pivoted in tbe centre and rolled around a stone circle on which the gorse was laid. The mill stones sometimes survive as gate-posts. It is a good and palatable feed for goats; the modern hammer mill with a coarse plate overcomes tbe problem of handling without making tbe product too dusty.

Of the straws, well-got pea and bean straw nre rich in minerals and well liked. Good oat straw is quite as palatable as inferior hay, and for the goat probably has a bigher feeding value. Goats eat the bead of each oat straw and reject the butt; tbey eat clean chnff with better appetite and little waste. Otber cereal straws are not well liked.

To silage goats, like cattle, take a ready liking once they bave overcome their initial disgust. But goats are more critical than cattle of silage quality and the losses around the outside of the silage heap nre consequently greater when the silage is fed only to goats.

The appetite of the goat for any one concentrate or nny one mixture of concentrates, fed in quantities of over 1 to 2 lh. per day, soon palls. Goats aren't fussy about the small amount of concentrate tbey get if fed at lower levels. Strange concentrates in the diet of a goat fed large quantities are nlways greeted with suspicion. Very high-yielding cows, who have a daily turnover of nutrients and minerals similar in relation to their body reserves to that of a moderate goat, reveal the same capriciousness towards their concentrate ration. The

root of the trouble presumably lies in the fact that no man-made compound or mixture of concentrates is adequately balanced. It is necessary to maintain variety in the ration, not only to maintain its palatability but to rectify the errors of one formula by those of the next.

Avoid groundnut cake for goats; it is not unpalatable but has been shown to be poorly utilized. For light rationing, whole oats and bran are liked and suitable. Maize germ meal and the maize residues from cornflour manufacture are among the cheapest, most efficient and most palatable sources of protein for the goat. Sugar-beet pulp, soaked or dry, is appetizing and rich in calcium; it is an ideal companion to silage, but if fed in quantity requires a phosphorus-rich accompaniment, such as bran. More use might be made of fish meal and herring meal in small proportions; it is mineral-rich and attractive to goats. Heavily fed goats scorning all normal concentrates have been known to consume poultry pellets to their advantage—possibly because of the fish-meal content.

But for the goat, of all animals, to have to tempt the appetite is a proof of bad management. Bad management is often necessary to win in the show ring with any kind of stock, and the show ring plays its part in serious food production. But the artistry of the goat-feeding bucket is a subject for goat fanciers and not for goat-keepers or goat farmers, to whom this book is dedicated.

WATER

The goat needs a clean and regular supply. If the available water is hard, allowance should be made for the fact in assessing the animal's need for minerals. 'High-calcium' phosphorus deficiency is a common cause of male infertility in hard-water districts.

The goat derives its heat mainly from the fermentation of roughage in the rumen; in winter-time cold water is only suitable for a goat with an ample store of roughage inside her.

In the important goat-dairying districts of the south of Spain it is traditional practice to warm the goat's water in the summer sun, as well as in the winter. The goats are yarded and fed a concentrated ration. But if the practice has been endorsed by the experience of two or three hundred years of goat farming on the Mediterranean coast, we clearly cannot afford to laugh at the notion of warming the drinking-water of any goat fed concentrates in appreciable quantities.

A dry diet with a restricted water supply will tend to fatten any

goat. Goats impose such a diet on themselves prior to the breediog season and during early winter, with the effect of reducing their milk yield and increasing their reserves of flesh and fat. An artificially stimulated thirst—hrought ahout hy adding salt to the drinking-water, or favourite feed—is used to increase milk yield. The same effect is achieved by feeding sloppy concentrate mixtures and dispeosing quantities of oatmeal gruel to stall-fed goats. Such techniques strip the goat's body reserves and put them in the milking-pail. If the goats are too fat they may be justified. Otherwise you bave your fun and pay.

Chapter 8

FEEDING PRACTICE

Under farm conditions the rationing of the goats will be done almost entirely by the goats themselves. It differs in no way from the general procedure of rationing dairy cows except that the pastures will usually cost less or nothing to grow, and the amount of bag feeding required will be less per gallon of milk and more easily measured.

We have now reached the end of a small instruction booklet on operating a highly efficient small milk-producing machine known as 'The Goat'. We have dealt with the subject of maintenance and running repairs, with fuel consumption and the suitable types of fuel; we have issued the necessary reminder to keep it topped up with water. All the 'The Goat' salesman has to do now is to point out to the customer that he will find in the end papers of the book all the requisite information about types of fuel available in the district. The customer must, of course, decide for himself how much milk he wants from the machine and fuel it accordingly. With a complacent farewell the salesman may now get into his delivery van and sail away.

This is, in effect, just what the conventional exponents of 'scientific rationing for milk production' do. If they don't exactly sell their customers a pup, they certainly sell an animal of some kind under the false pretence that it is a machine.

The swindle is not immediately apparent. If you buy a goat which gives a gallon of milk a day, and which the railway consignment note shows to weigh 140 lb., and you feed her in accordance with the formulae given in this chapter,

i.e. for Maintenance $0{\cdot}9 \times 1{\cdot}4 = 1{\cdot}26$ lb. starch equivalent
and $0{\cdot}09 \times 1{\cdot}4 = 0{\cdot}12$ lb. digestible protein
for Production (1 gallon) $= 3{\cdot}25$ lb. starch equivalent
and $0{\cdot}5$ lb. digestible protein
All incorporated in $6 \times 1{\cdot}4 = 8{\cdot}4$ lb. dry matter and in palatable form. . . .

then you are not likely to experience any serious trouble for some time. You will, of course, cut down her ration as her yield declines in the later stages of lactation. In early autumn she will show some signs of being unsatisfied with her diet and will raid the food-bin if she gets the chance. By Christmas she will have little appetite even for a small ration and will probably go dry. During late January and February she will show further signs of being unsatisfied with her ration; when she kids in March she will yield only 6 pints a day instead of eight. You will then become very angry with 'scientific rationing', decide that you have been underfeeding the goat (which is quite true) and proceed to give a much more concentrated ration. The effect on the goat's yield will be slight and transient; the effect on her health may be greater. Autumn will probably find you trying to bolster up a declining yield with ever-mounting heaps of concentrates. Usually during the first half of September, but often nearer Christmas, you will end your experiment in 'scientific rationing' as you fill in the grave.

The Metabolic Cycle

There are empirical 'wrinkles' which avert some of the consequences of mechanical rationing; most helpful is the instruction to 'steam up' a goat before kidding; that is, to provide a full production ration during the last eight weeks of pregnancy. Even this job can be done more efficiently if you understand the reason for doing it, and if the process is part of an all-year rational scheme of feeding, which treats the goat as an animal and not a machine.

The crowning fallacy of mechanical rationing is the notion that the goat's expenditure of nutrients should exactly balance her income on a day-to-day basis. In reality, like so many flourishing agricultural enterprises, the goat lives on her overdrafts for a large proportion of the year, and it is only during the last few weeks of pregnancy that the balance is struck and her solvency tested.

The advantages of the arrangement are easily seen. During the late summer, autumn and early winter the goat's milk production is relatively light and her digestive capacity is not fully employed in supplying her udder. Given the opportunity she can at these periods lay up a reserve in her body, on which she can draw during the following spring and summer when the demands of her udder will usually exceed the through-put of her digestive system. Like a good motor-cyclist, she takes her corners before she comes to them, so that at the point of greatest danger there is less stress.

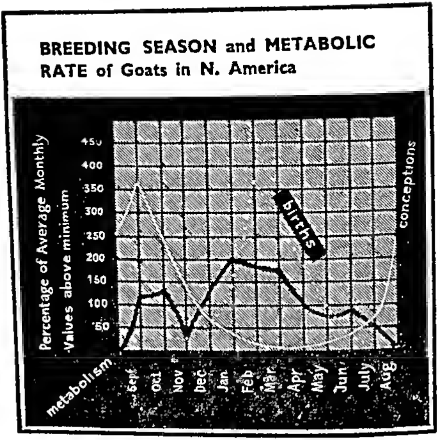


Fig. 14*

The agency by which this arrangement is regulated is the activity of the thyroid gland, which controls the goat's metabolic rate—the speed at which her body processes work, her activity and appetite. In Fig. 14 the course of the goat's metabolic rate during the course of the year is illustrated. It will be seen that this course is very closely tied with the needs of the breeding season. The exact timing of the metabolic cycle does vary with the timing of the breeding season, which begins nearer to mid-summer as the goat lives nearer to the Pole (North Pole in the northern hemisphere and South Pole in the southern hemisphere). This shift in timing makes it exceedingly difficult for goat breeders in Scotland to record milk yields as high as those obtainable farther south, because the peak of the metabolic

* After Asdell and Turner, *Missouri Agricultural Experimental Station Research Bulletin* 291 (1938).

rate of goats in Scotland is reached at a time of year when natural feeding is poor.

Metabolic rate reaches its lowest level in early autumn, about three weeks before the onset of the breeding season. The most obvious indication of this stage in the cycle is the sudden drop in yield of the milking goat, which continues for about a week and then stops, the yield remaining at the lower level as regards quantity, but improving in quality. No purpose is served in trying to oppose this fall in yield. Immediately the fall becomes apparent, introduce, or allow the goat access to, rougher and drier forage, the drier ration will assist the goat to divert its food into building reserves for next lactation.

As soon as the yield settles down at the new level the appetite of the goat increases rapidly. Feeding during the subsequent month is specially important for the goat's fertility, should enable her to make substantial weight gains and fit her to face the chills of autumn. The diet should remain dry and rich in fibre; the energy value of the ration should rise to that of a full production ration at the height of the breeding season, but the protein content of the ration can be relatively low—1 part digestible protein to 8 parts starch equivalent for a goat whose yield at the time has fallen to under 4 pints or a 1:7 ratio for heavier milkers.

After the peak of the breeding season is passed the yield and appetite of the goat declines until mid-winter. Feed in sympathy with this decline, maintaining a dry type of diet relatively rich in energy (carbohydrates) and fibre.

The recurrent periods of 'heat' during the breeding season affect different goats in different ways. In some goats the secretion of hormones is so powerful in relation to the activity of the thyroid that milk yield almost ceases; but in a goat with a very active thyroid the opposite effect may be produced. In either case it is an inherent characteristic of the goat which diet does little to alter.

Whether the goat milks through the winter or dries off before mid-winter depends on the activity of the thyroid, and on whether she is in kid. While the activity of the thyroid is largely an inherent characteristic, maximum activity (and therefore productivity) for any one goat is secured by feeding in full sympathy with the fluctuations in metabolic rate. The greater liberty the goat has to select her own ration in type and quantity the more exact will be the sympathy. Man-designed rations are at best a necessary evil.

The common and fatal error is to adopt a feeding policy designed

to secure a high uniform level of production throughout the year. To do so is to fight a pitched battle with the glandular rhythm of the goat and the whole patterning of its vital processes; to turn the goat into a battlefield for an idiotic contest between the veterinary profession and the agents of disease.

Winter Feeding

From mid-winter until early spring the metabolic rate of the goat rises steadily to its maximum level. The goat-feeder's job is to organize a crescendo of quantity, quality and palatability in the feeding-racks to support the natural upsurge of productivity and add impetus. But some caution is necessary if the goat is in kid, and especially if she is naturally capable of high yields.

Winter production is a drag on the development of the condition and vitality if the goat is also supplying the needs of growing kids in her womb. In any goat that milks past mid-winter the yield will increase as the days lengthen; if the early increase is given much encouragement a good milker will milk till she kids again; the strain on her resources is excessive and her performance in the subsequent lactation will suffer.

To dry off a goat of a high-yielding strain is not easy; mere starvation gives unsatisfactory results. But there is no objection to restricting water intake and making her diet as dry as possible over a short period. A teaspoon of cod liver oil per day will give assistance. By these means, and by milking irregularly and without stripping, every effort should be made to ensure that the in-kid goat has ended her last lactation at least eight weeks before she is due to start her next.

The goat who is in kid but not in milk after mid-winter also requires cautious feeding during the early part of the year. A high level of feeding throughout pregnancy makes kids that are too big to be born with ease: if the diet is also high in minerals the bones of the kids will be too hard and solid at birth. A gently rising, dry, and fibrous diet with a rather low-protein content is indicated. The kids grow very slowly during the first three months of pregnancy and their food requirements are insignificant.

'Steaming Up'

During the last eight weeks of pregnancy, the growth of the kids is rapid, and the metabolic rate of the goat rises rapidly. Through this period the content of the ration should rise to the level of the full production ration—that is the theoretical requirement of the goat

when giving the peak yield that is expected of her—and the level should be reached a week before the goat kids. At the same time the dry nature of the ration should be changed and the sappiest materials available supplied in lieu.

It is hard to design a sappy, rich diet in early spring, when the marrow-stem kale is reduced to blasted stumps and most of the roots have been used to make the ration too succulent in early winter. But with planning it is possible: hungry-gap kale will be fruitful at this time and so will Russian kale. Mangolds, fodder beet and carrots can be stored for the occasion. In southern districts comfrey will be making succulent growth. At the worst, sugar-beet pulp can be fed soaked instead of dry. But in the effort to increase water intake the objection to cold water must not be forgotten.

For three or four days after kidding the level of the diet should be lowered and made more fibrous, to minimize the shock to the goat's udder and metabolism of the sudden flow of milk. Thereafter it should return to the previous top level and stay there for three or four weeks. After the lactation is well established the goat can safely be fed a little below her theoretical requirements. She should be carrying the makings of many gallons of milk on her back and chest and should be allowed gradually to dispose of the burden into the milk-pail. During the first four months of lactation the milking goat should lose weight steadily.

This system of feeding is less revolutionary than most goat-keepers will believe at first sight. In essence it is the system which has been used in the dairy cattle herd belonging to Boots Ltd., under the supervision of Mr. Stephen Williams, M.Sc., for the past twelve years. This herd is characterized by regular calving, complete freedom from chronic contagious mastitis for the past twelve years, freedom from digestive disorders and complete freedom from tuberculosis. It can claim a 305-day herd average of 940-1,000 gallons, a pattern of progressive lactations—850, 950, 1,000, 1,100, 1,200 gallons—and a number of 10,000-gallon cows.

The system suggested accords well with that recommended by the late Mr. Newman Turner for cattle—and it is surely remarkably solid ground upon which Boots Ltd. and Mr. Newman Turner can find a common footing.

The natural metabolic cycle of dairy cattle has been messed up by winter breeding and their daily dry-matter capacity extends only from 2½ to 3½ per cent of bodyweight. For goats, who have a restricted

breeding season and a far wider range of capacity, the system clearly has greater merits.

The main merit of the system lies in the fact that it spreads the work which has to be done by the goat's digestion more evenly over the year. This makes the daily task of digestion sufficiently small, to enable the goat to obtain by far the greater part of her food requirements in the form of fresh greens and roughages which she can ration for herself.

Frequency of Feeding

When a goat cannot obtain what she wants, when she wants, not only have we the risk and labour of rationing her, but we must see that her ration is split into small and frequent feeds. Feeding with the flock on free range all day the goat eats a little, ends a little and eats a little again; shut in a yard or stall with other goats or alone, or allowed out to graze for a restricted period, the goat stuffs all she can while it is there. The difference in the food value of a given weight of fodder has been shown to be twice as great if the day's ration is divided into five parts offered at intervals during the day than if it is all fed at one time or, to put the matter in a more frightening way, the goat needs twice as much food per gallon of milk produced if the food is fed at a single feed than if it is fed at five separate feeds—what is more, she will eat it. This is fairly well understood in normal stall-feeding practice—but it tends to be forgotten when goats are put out to graze for restricted periods.

The reason for the importance of the 'little and often' principle is that the rumen bacteria attack the contents of the rumen as long as it is there. At first their attack results mainly in the conversion of fibre into digestible sugars and the release of the digestible substances locked in the fibrous cells. But if the food stays long in the rumen the digestible sugars and proteins so released are broken down into heat and gas. With frequent feeding small quantities of food pass rapidly through the rumen and the nutrients in them are digested by the goat: with massive single feeds the food remains packed in the rumen for a long period and sustains heavy losses.

Goats put out for two or three hours' grazing and brought in again benefit little more than if they were out for a quarter of an hour.

Feeding for Butter-fats

The capacity to produce milk with a high percentage of butter-fat is inherited, butter-fat percentage being one of the easiest breed

characteristics to fix. But the ability of an individual to exercise her inherent capacity for butter-fat production depends on several other factors. To understand the situation it is necessary to take a closer look at the goat's internal economy.

The goat's rumen (first stomach) is a fermentation vat, where all she eats is fermented by bacteria and changed into the substances which the goat actually digests and absorbs. Though some food may pass through too quickly to be changed—dairy nuts on an empty stomach, for instance—most food is utterly changed before it is presented for true digestion, or for absorption through the walls of the rumen itself. Energy foods are absorbed in the form of fatty acids; the sugars and starches, which constitute most of the energy food in green fodder and concentrates, are changed into butyric and propionic acid; the cellulose, which comprises most of the fibrous matter in the diet, is changed into acetic acid. The goat depends upon the supply of acetic acid to make her butter-fat.

To realize her inherent potential for butter-fat production, the goat needs, not only an adequate proportion of fibrous fodder in her diet during lactation, but also to be so reared and managed as to develop to the full the capacity of her digestive organs, so that she can accommodate so bulky a diet in sufficient quantity.

The average butter-fat percentage recorded for a milking goat over a complete lactation will reflect her inherited potential, modified by the way in which she was reared, the degree of maturity at which she kidded, and the nature of her diet during lactation.

Rearing methods affect butter-fat percentage by modifying the development of the digestive organs, especially the rumen. The ultimate size of the rumen is stunted by feeding more than 4 pints of milk a day to a female kid, or feeding substantial quantities of milk to kids over four months old, or feeding more than 1 lb. of concentrates a day to kids or maiden goatlings. The stunted organ cannot accommodate enough fibrous fodder to do justice to the goat's inherent capacity for fat production.

The degree of maturity at which a goat kids limits the size of rumen, her capacity for fibre and her butter-fat potential, during that lactation. There is little growth in a goat's frame and digestive organs during the last two months of pregnancy and the first three months of lactation; but if adequately fed during the later stages of lactation, a young goat continues to develop for several years. Goats who start breeding as kids may indeed be permanently stunted and their butter-fat production permanently impaired. But the practice of 'running

through' (extending the lactation over two years, without breeding) helps productive young goats to complete their growth and develop their butter-fat potential to its full. A goat's butter-fat production should continue to improve until it is five years old.

The effect of diet on butter-fat is not confined to the need for an adequate proportion of fibrous food. As explained in the previous chapter, lack of salt or cobalt in the diet results in diminished appetite, and impedes the fermentation of fibre in the rumen, so restricting butter-fat production. Worm infestation raises the salt and cobalt requirement of the goat and accentuates the effect of dietary deficiency. Vitamin B_{12}, synthesized from cobalt by the rumen bacteria, is used by the goat in the metabolism of butter-fat. A slight deficiency of this vitamin may result in lowered butter-fat production, imperfect metabolism of acetic acid to butter-fat and bitter-tasting milk. Such a deficiency may be caused by worm infestation, lack of fibre in the diet, lack of cobalt, or all three misfortunes concurrently.

Of course, the more milk a goat gives, the more fibre she needs in the diet to sustain a maximum percentage of butter-fat. When the proportion of fibre in a diet rises above a certain level, milk yield falls. For any individual goat, there is a point at which milk yield can only be increased at the expense of butter-fat, and butter-fat percentage only improved at the expense of milk yield. The level at which this occurs depends mainly on the size of the goat's rumen.

The embarrassing fall in butter-fat percentage which occurs in the show-yard, and the chronically low butter-fats when goats go out on to lush spring grass, can both be prevented by a substantial feed of hay, morning and evening; this seldom has any adverse affect on yield.*

In feeding for butter-fats, it is well to remember that there are some variations in butter-fat percentage that have nothing to do with diet. There is the seasonal variation, illustrated in Fig. 15, which is determined by the basic metabolic cycle of the goat and is practically unchangeable. Variations in milking routine may be reflected in butter-fat percentage. Equal intervals between milkings tend to maintain a steady proportion of butter-fat in the milk. If the intervals are uneven, in the milk taken after the longer interval, the percentage of butter-fat is reduced; in the milk taken after the shorter interval it is correspondingly increased. The first milk drawn at a milking is low in butter-fat; the last milk—the 'strippings'—rich in butter-fat. Occasional failure to 'strip out' and extract the last available drop, lowers

* Low butter-fat at shows may be due, also, to anxiety inhibiting 'let down' (p. 275).

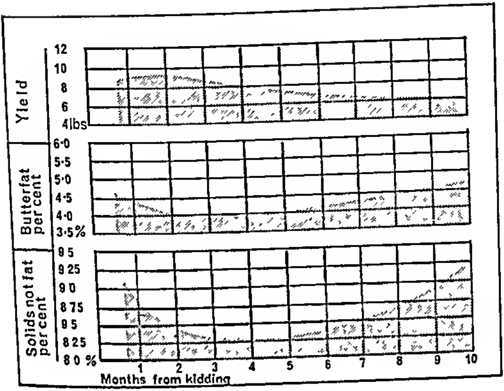


Fig. 15. Lactation Curves

the percentage of butter-fat at the milking at which the failure occurs; but the loss is recovered at the next milking; regular failure to 'strip out' does not affect the total yield of butter-fat.

The Collapse of Productivity

The average yield of goats at agricultural shows has dropped by 20 per cent in fifteen years. It dropped by 12½ per cent in the four years which followed the effective derationing of animal feeding-stuffs in 1949. So sudden a fall excludes the possibility that bad breeding policies were mainly to blame, and its timing points to the major cause.

During the years of war and 'austerity', the official concentrate ration for a goat producing a reasonable yield of marketable milk was seldom inadequate for a goat which had access to plenty of bulk food—grazing, roots and hay. The allowance for kids and goatlings, and for milk used for kid feeding, was very much more restrictive; it was the feeding of young stock which changed most drastically with the availability of concentrates.

The hindsight offered by Fig. 16 allows us to recognize that the restriction of milk and concentrates for kid-feeding resulted in higher

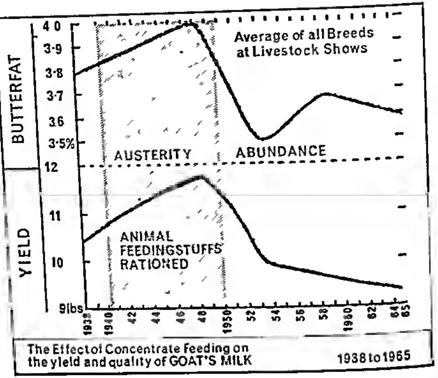


Fig. 16. The Effect of Concentrate Feeding

yields, with a higher percentage of butter-fat, in the mature goat. As we have shown above, full development of the rumen, necessary for satisfactory hutter-fat production, is impeded hy feeding excessive quantities of milk and concentrate to kid and goatling. Although *percentage* of hutter-fat and yield of milk often vary inversely to each other, *total butter-fat production* and yield of milk usually rise and fall together. To put tbe matter in anotber way, both butter-fat and protein are essential constituents of milk, and tbe proportions of eacb in tbe milk are characteristic of the species and of the individual goat; within these cbaracteristic proportions, tbe percentage of protein or butter-fat in the milk varies a little with the composition of the diet. But if the diet fails to provide the makings of enough protein, or enough hutter-fat, to maintain the cbaracteristic pattern, tben the yield falls.

British Goat Society show regulations heavily penalize a low butter-fat percentage, and encourage exhibitors to hreed for higher butter-fats. But unless better kid-rearing methods permit better

rumen development and better butter-fat production, the higher the butter-fat characteristic of the goat, the smaller her yield will be, as Fig. 16 so tragically records. British Goat Society show regulations also endorse the unparalleled practice of holding kid classes, where the most overfed kid, with the most stunted rumen development, usually wins. The aesthetic effect of kid classes is delightful; their effect on productivity is utterly malignant.

It may seem unwise to base so much argument on show-yard records, and to disregard the evidence of the official milk records. In fact the records of the few goat flocks which are officially recorded confirm the general trend shown by the show records. The show records are preferred because they cover a wider spectrum of goat breeders and because show yields are produced in public by public methods. In some recorded herds, all the milk which cannot be bottled into kids is fed back to the goat who gave it and the official records refer to milk circulation rather than milk production!

In analysing the three thousand, or so, show records which went to the making of Fig. 16, it was striking to note how many of the high-yielding goats of the 1950s were unpedigreed goats, or goats with an unregistered dam. These were the last of the cottagers' goats; reared cheaply on bulk foods, they had a good capacity for bulk; by the time they reached the show-ring, their yields, though high, were low in butter-fat, signifying the over-concentrated diet favoured by the show-ring enthusiasts. In the 1965 show records, this type of goat is not to be found. Presumably, the show-ring has debauched the last of them.

But who can blame the poor ignorant exhibitors, when the Nutrition Expert, in charge of the goats at a major agricultural research station, can stand up in front of the International Dairy Goat Conference and state, *ex cathedra*, B.Sc., Ph.D., that the maximum daily capacity of the goat for dry matter was but $2\frac{1}{2}$ to 3 per cent of its bodyweight . . . ? (cf., p. 164). Was Divine Providence ever so insulted?

Breeding stock for goat-improvement schemes all over the world come from the mountains, where low temperatures, tough, frost-resistant herbage, stimulate the development of bulk capacity from birth to maturity. If we wish to restore British goat productivity to its former glory we must create mountain conditions in the goat house, as we were reluctantly forced to do by wartime and post-war shortages.

THE FEEDING OF YOUNG STOCK

The milking capacity of a goat is in the main an inherited characteristic, dependent principally on the inherent activity of her thyroid gland. In feeding for production we feed in sympathy with the fluctuations of the goat's natural metabolic cycle, to secure maximum thyroid activity and maximum use of the goat's milking capacity.

But in rearing young stock, the best that good rearing can do is to condition and modify the development of the kid's digestive organs to suit it for the diet it will receive in later life. The natural growth rate of kids fluctuates in sympathy with the metabolic cycle of adult goats (Fig. 17). Though we feed the kid in sympathy with these

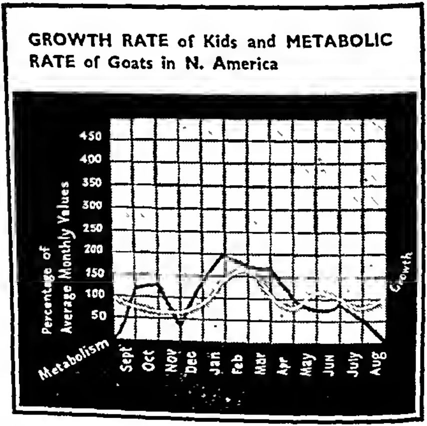


Fig. 17*

* After Asdell and Turner, op. cit.

natural fluctuations in growth rate, there is no good purpose served in attempting to achieve maximum thyroid activity or the rapid sappy growth that such activity produces in the young goat. Rapid growth always endangers the potential productivity of the kid in later life.

The principal feeding problem of milking goats concerns the maintenance of a correct mineral balance. This is true for even the more moderate milkers; high-yielding goats need a highly mineralized diet on which they have to maintain an extremely precarious balance between calcium deficiency, phosphorus deficiency and iodine deficiency. The best insurance they can have against disaster in the process is the possession of substantial mineral reserves banked in their bones, on which they can draw in emergency. A well-mineralized skeleton is made during the first eighteen months of life or never at all. The potential value of a kid of generally good type lies largely in the invisible minerals secreted in its bones.

The job of the kid rearer is to build well-mineralized skeletons; the job of thyroxine in the blood of the goat is to divert the dietary supply of minerals away from the skeleton and into the soft tissues. So we must curb excessive thyroid activity—that is, maintain a normal growth rate. The more milky the pedigree of the kid, the more urgent and difficult this task becomes.

The contrast between this advice and the practice of many leading pedigree breeders is so violent that it is necessary to emphasize that it is based on a massive, unanimous and recent scientific support. (Owen, *British Journal of Nutrition*, 6, 415; Fairbanks and Mitchell, *Journal of Nutrition* (1936), 11, 551; Zucker and Zucker, *American Journol of Physiology*, 146, 593; Duckworth and Godden, *Journal of Physiology*, 99, 1; Duckworth, Godden and Warnock, *Biochemical Journal*, 34, 97.)

The normal growth rate of kids is shown in Fig. 18 and represents a daily weight gain of about ½ lb. per day for the first six months of life. The quicker growth of the male kid, castrated at birth ('castrate' on the graph) will be interesting to any who are interested in the meat potentialities of surplus kids.

Such normal growth can be obtained on the following régime:

Wherever possible the kid should be allowed to suck its mother for the first four days of life. The arrangement is as helpful in conditioning the mother's udder as it is in giving the kid the best possible start.

If the kid must be bottle fed at birth, it must be fed with the milk of its mother or that of a freshly kidded goat. It matters relatively little, from this point of view, if the mother has been pre-milked, or

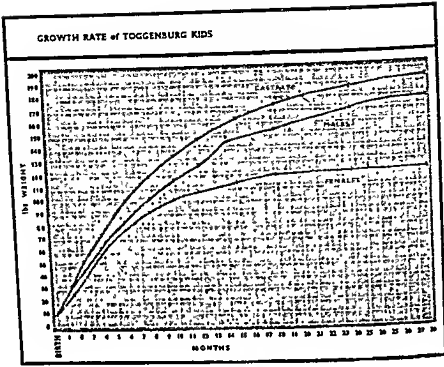


Fig. 18*

only finished its previous lactation a day or two before kidding. The importance of the kid receiving milk from a freshly kidded goat lies in the rich vitamin-A content of such milk and its wealth of anti-bodies to give protection from disease. Such milk is also laxative. In spite of pre-milking, the milk is enriched with vitamin A only by the act of kidding. The milk of the goat will permanently contain anti-bodies to all or most of the infections to which she is exposed; the supply will be less rich in the milk of a pre-milked goat, but still adequate; but the laxative properties of the milk are reduced by pre-milking, and the kid fed on it may be given a teaspoonful of medicinal paraffin one hour after each feed for the first twenty-four to thirty-six hours. If given with the feed the liquid paraffin will reduce the vitamin-A potency of the milk.

For bottle feeding a kid during the first few days of life a polythene baby feeding-bottle with baby or soft lamb teat is most convenient. The flexibility of the polythene bottle enables the feeder to 'let down' the milk, so that the kid is not embarrassed with the effects of the

* After Brooks and Asdell.

vacuum its sucking creates.* The kid should be allowed to take as much milk as it wants at six feeds in the day. The bottle should be sterilized after each feed, and the goat milked anew for each feed.

At four days old most kids will be weaned from their mothers on to the bottle. Purely from the viewpoint of rearing the kid well there is no objection to the average kid being allowed to suck its mother all the summer; but exceptionally well-bred kids are better to be bottle fed, or they may grow excessively fast. Though rapid growth on a milk diet in which the minerals are well balanced is unlikely to produce mineral deficiency in the skeleton, it can only be achieved by consuming such large quantities of milk that the digestive system of the kid becomes distorted. The second stomach of a calf has been shown to increase in size by fifty-four times in the first three months, when the calf is fed a normal diet including roughage. On an all-milk diet it increases in size only three times in the same period. A kid fed abnormally large quantities of milk, direct from the mother or out of a bottle, will not have a normally developed rumen. The longer the milk diet is maintained the more permanent the deformity will become. In effect protracted feeding of a big milk ration produces the handsome-looking goat who is unable to realize her innate capacity for milk production.

Four pints of milk a day, in four feeds, is adequate for any female kid. A billy kid may have an extra pint. This level of feeding will usually be reached when the kid is a fortnight old, if the feeder allows the appetite of the kid to guide him. A wine-bottle or calf-feeder replaces the baby bottle at this stage.

At the age of a fortnight kids will want to nibble soil to satisfy their needs of iron and copper, in which the milk is deficient. There is a certain risk that if allowed to nibble the soil round about the goat sheds the kid will pick up an infestation of the tape worm, *Monezia expansa*, which will rob it of calcium for the next six months. To minimize this risk the kid should have access to a mineral lick or a box of clean earth—we will naturally want to give it the best earth we have got, but the best for the purpose is second-spit subsoil or the mole-hill the kid will usually select for itself—and certainly not compost.

At this stage, too, the kid will start nibbling hay and should be

* More recently there has appeared on the market the 'Even-flo' nylon baby's bottle, which has every virtue the kid-feeder could wish for—a teat which regulates the flow, prevents vacuum, and cannot be swallowed by a kid, a wide neck for easy cleaning, and made of unbreakable material.

allowed to do so. But hay nets have hanged a lot of kids. The hay is best placed on the ground and the wastage accepted.

The introduction of milk substitute can be started at this age if the goats' milk is urgently needed elsewhere. Perfectly satisfactory results seem to be achieved by the use of these substitutes if care is taken to follow the makers' instructions exactly and to carry out the introduction little by little. No rearing method can be judged by appearances; when a number of goats able to sustain yields of over 300 gallons a year, without mineral deficiency or digestive troubles, have been reared on milk substitute, it will be time to endorse the claims of the makers. One thing is sure: these substitutes contain none of the antibodies to the infections prevalent in the district which are conveyed to the kid by natural milk. Rigid adherence to the routine of sterilizing the feeding-bottle after each feed is therefore necessary. If the kid scours, miss a feed and reduce the proportion of substitute.

On milk feeding, scours result mainly from the use of dirty bottles or the offering of cold milk. Milk should always be given at blood heat. Where facilities for warming milk immediately before the feed are lacking, fill a large thermos with boiling water and heat the bottle in it when the time comes. On no account should the milk be kept warm over a long period.

From two weeks until four months old the kid needs no more than her 4 pints of milk a day (which provide the food equivalent of ¾ lb. of concentrates), and access to sunshine, fresh green food, salt and water. Skim milk may be used to replace part of the milk ration at three months, in which case a handful of oats or flake maize may be offered in lieu of the fat.

At four months milk may be reduced from four pints to three in the day; at five months from three to two; and at six months from two to one. After a further fortnight bottle feeding should be stopped. As the milk is reduced it should be replaced by good-quality roughages if available, and preferably not by concentrates.

Though the growth rate of the kid may slow down as a consequence, the digestive organs will develop their capacity for bulk and the appropriate bacterial population to deal with it.

Goat-keepers tend to spend more time than necessary on kid-rearing—partly, perhaps, for the sound reason that it is a delightful occupation, but partly too because of a misguided determination to see that the future generation get the best of everything. Owing to the concentrated and highly digestible nature of their basic diet, milk-fed kids can, in fact, thrive on rougher fodder than adult stock. They will

eat that portion of the hay which their mothers reject, not out of youthful indiscretion, but because their needs are more modest; in the same way the kid will be chewing twigs while her mother is eating leaves from the same shrub. The only fodder which is suitable for adults but unsuitable for kids is that which is too nutritious for the latter.

Most of the traditional anxiety to separate kids and adults at pasture, and to provide the kids with special fodder, is the fruit of the bitter experience of running young kids and adults together on good grass. Young pasture grass is too rich in nutrient and poor in minerals to be a safe staple diet for adult goats; for kids it is definitely dangerous in quantity. When wet, it forms a cold, tight-packed, indigestible wad in the kid rumen, as many a sad post-mortem examination has revealed.

We shall greatly improve our pastures if we include in them a substantial proportion of deep-rooting 'herbs' such as burnet, chicory, dandelion and yarrow; these contain more minerals than grass does and make the pasture healthier, but no less productive, for milking stock—goat, cow or ewe. On such a pasture kids may be safely put out to graze at two or three weeks of age, if the 'herbal' content is making a good showing—just as they can go out on scrub browsing. But if the pasture is of the conventional grass and clover type, up to at least three months of age, kids must receive a good feed of hay before they are put out, and must never be put out if the grass is wet.

The heaviest mortality in kids occurs during their first autumn and in the following spring. The fatal disease is usually either pneumonia or enterotoxaemia, in many cases aggravated by worm infestation. All these agents of disease are normally present in the body of the healthy kid.

Disease is no more caused by specific bacteria or parasites, than Christmas is caused by the overloaded postman. You can suppress the symptoms of disease or Christmas by obstructing the bacteria, parasites or postmen, but in so doing you neither remove the cause nor prevent the recurrence of symptoms. The cause of disease is the condition which allows the agents of disease to become over-active.

Kids and lambs develop heavy worm infestation in autumn if they lose much weight after weaning; that is, if their digestive system has become too dependant on milk, or if the after-weaning diet is unsuitable. They become heavily infested in spring if available feeding fails to improve in quality in sympathy with their increasing metabolic rate and appetite; that is, if they are either half-starved all the

time, or fed so generously through the winter that it is impossible to pack more food into them in the spring. Pneumonia affects mostly the leaner kids in these categories; enterotoxaemia tends to affect the fat and thriving ones—especially the unweaned kid, fed enough concentrates to carry the rapid growth of summer on into the winter. Cases of enterotoxaemia and pneumonia are often precipitated by sudden changes in diet or weather, but the same changes do not affect all kids alike. They affect the kids who had too much milk in their first summer, or too much concentrate in their first winter, even more than they affect the starveling and weakling.

The ability of the kid to thrive on bulk foods and roughages alone is not fully developed until it is about nine months old. The March-born kid, weaned at about four months old, will thrive on the common run of grazing and browsing into the autumn, for the gradual bardening of the fodder matches the kid's developing powers of coping with it. Later-born kids, weaned at the same age, need to have the pick of the bulk foods available if they are to maintain progress. Cabbages, kale, good stubble and aftermath grazing, are adequate feeding for the late kids after weaning. If they must put up with lower-quality bulk foods they will require a supplement of concentrates, preferably such as oats or bran, which have a moderate fibre content. Good hay, with a maximum of 1 lb. per day of concentrates (7 parts starch equivalent to 1 part digestible protein), will see any kid through the winter until the beginning of February; the more foraging and exercise it can receive in the meantime the better. From February on, feed a wetter diet, using 'hardy green' turnip tops, fodder beet, sugar-beet pulp, 'Hungry Gap' and 'Asparagus' kale, etc. At the same time step up the protein in the ration to a 1:6 ratio, until the new grass comes; then drop the protein content, phase out concentrates altogether, but go on feeding hay, morning and evening, until the first flush of grass is over.

Once safely into its second summer, the kid ceases to be a problem child and becomes a goatling, needing nothing but her fill of fresh fodder, salt and sunshine, until she joins the ranks of the breeding adults in early autumn. Overfed goatlings are liahle to summer mastitis, hut there is no call to feed concentrates to a goatling until she is in kid, and no possibility of a goatling heing overfed on hulk foods.

Sometimes a kid is purposely or accidentally served during her first autumn or early winter. This is most likely to occur to a growthy kid, highly stimulated by its diet. In many ways it is the best thing to happen to such a kid; as goatlings they tend to be over-fat and

minerally imbalanced and difficult to get in kid. But all kids are sexually potent at a young age and a normally developed kid can easily be served at six months or younger. In any case, the kid who has to build its own bone and body and that of the foetus and at the same time to lay up reserves for lactation, is going to be hard pressed for calcium, phosphorus, vitamin D and general nutrients. But the same pattern of feeding must be followed, whether the kid is served or not. Only from the beginning of February is it safe to feed the immature first kidder on a diet rising to substantially higher levels. During the earlier part of her pregnancy the most that can be done is to ensure a highly mineralized diet with a vitamin-D supplement. The main danger in feeding the immature breeder lies in over-generosity; it is sufficient that her ration should rise during the last week of pregnancy to a maintenance and production ration for her actual weight and 6 pints of milk. After kidding this ration should not be increased, except in rare cases; the lactation should he curtailed as soon as possible if good suhsequent performance is to be expected.

Billy kids should always he serving when they are about six months old; if they will not serve then, they never will and should be destroyed without more ado. Consequently, and to meet their rather faster growth rate, billy kids get more milk (5 pints a day) in their bottles, may be fed the full amount up to the age of six months and continue to receive 2 pints a day for the duration of the breeding season. Otherwise male kid feeding follows the lines already indicated for their sisters.

It is common practice to restrict the activities of valuable pedigree billy kids to about six services in their first season. The practice does no harm, as the kid, if not adequately employed, will masturbate continuously. Though the effect of a lot of work is to reduce the male kid's condition during the autumn and early winter, it has not been shown to reduce his subsequent fertility; unless allowed to accumulate a heavy worm infestation while in low condition, a rising level of feeding in early spring will restore the kid to condition. After summering on an *ad lib*. supply of fresh fodder, such a male is more likely to make a vigorous and fertile sire than one which has never lost its puppy-fat. The ideal is to give the billy kid enough work and food to keep him in good lean condition.

Male goats are always available in ample supply, and are very cheap. Unless supremely well bred their main value must lie in their stamina and resistance to current ills. It is pointless to provide them with too sheltered a life.

SAMPLE RATIONS

In designing rations for dairy cattle it is common practice to provide their maintenance ration in the form of roughages and their production ration in the form of concentrates. This system works passably well, because, as Fig. 9 shows, the maintenance requirement of the cow is round about half of its total requirement of energy foods, and doesn't need much protein. So the cow gets half its energy foods in the form of roughages, in which the starch equivalent forms one-third of the dry matter, and the other half in concentrates in which the starch equivalent forms two-thirds of the dry matter. In the whole ration, therefore, there are about 50 lb. starch equivalent in 100 lh. of dry matter; this degree of concentration is about the same as that of the better natural pastures which are the cow's natural food.

The arrangement also produces automatically a reasonably good mineral balance in the diet—half the food value being in the form of lime-rich roughages and the other half in phosphorus-rich concentrates.

The maintenance requirements of the goat are relatively small, and of her relatively large 'production' ration, a bigger proportion goes to provide the *energy* to carry out high-speed food conversion. If you design goat rations on the dairy cow basis, you get a third of the ration in the form of roughages and two-thirds in the form of unbalanced concentrates—giving an overall ration which would be too concentrated for a cow and much too concentrated for a goat.

As the ordinary roughages are not sufficiently rich in lime to balance twice their food value in phosphorus-rich concentrates—the resultant ration is also minerally imbalanced, in most cases. So the belief has grown up that high-yielding goats must have all their roughages and much of their fresh green food in the form of calcium-rich legume hays and fodders, supplemented by calcium-rich beet pulp and calcium-rich seaweed meal. It is indeed a fact that goats fed more or less in accordance with this arrangement will not eat any other kind of hay; it is also a fact that given this type of diet, which contains about four times as much lime as a high-yielding goat actually needs for maintenance and production, the goat is unable to breed, milk satisfactorily, or even keep alive, without a very large phosphorus-rich concentrate ration, to keep the mineral balance.

As far as quantity is concerned, it is very much more satisfactory to give the goat her maintenance ration in the form of concentrates

and her production ration in the form of roughages. For a 150 lb. goat, that is 150 × 0·9 = 1·35 lb. starch equivalent or 2 lb. of concentrates per day. Concentrate foods and mixtures normally provide enough protein to leave a large surplus over the goat's maintenance needs to be 'carried forward' into the production ration of roughage. This ration of 2 lb. of concentrates in a day is adequate and suitable for the needs of any goat giving up to 11 pints of milk a day at her peak yield; for a goat that doesn't give less than a gallon at peak yield the same ration can be continued until her yield drops below 4 pints. At this level of production it is more economical to reduce the concentrates by ½ lb. for each 1 pint fall in yield—always assuming that there is an adequate supply of fresh food and hay to keep improving condition.

The Kinloch Herd boasted a recorded herd average of 4,344 lb. in 365 days on the produce of a marginal land holding in the Galloway hills. Concentrates are limited to 2 lb. per head per day, mainly in the form of home-grown bruised oats; bulk feeding consists of rough grazing, supplemented by successional crops of rape, kale and drumhead cabbage, with a patch of oats and tares to fill the gap between rape and kale. Winter feeding is based on tripoded hay from herbal leas; roots used are carrots and potatoes. The goats kid once in two years.

These methods produce about 50 per cent more milk per acre than could be produced by good cows on far better ground. (See plates 19–22.)

The following sample diets are designed with this scheme in mind. In formulating the concentrated part of the ration, the mixtures have been made to accord in general food values with the dairy compound cakes on the market, as far as possible. So a proprietary compound can replace any of the mixtures (1), (2) and (3) without altering the balance of the whole diet.

CONCENTRATE MIXTURES

(1)

30 lb. Cotton seed cake
30 lb. Linseed cake
40 lb. Sunflower seed cake
100 lb. Flaked maize
100 lb. Whole oats
100 lb. Whole rye
40 lb. Seaweed meal.

100 *lb. contains;*

66·5 lb. starch equivalent, 12·4 lb. digestible protein, 87 lb. dry matter.

2 *lb. contains;*

1·33 lb. starch equivalent, 0·25 lb. digestible protein, 1·7 lb. dry matter.

In this mixture it is possible to ring the changes by replacing any oilcake by any other oilcake, and any cereal by any other cereal, provided the proportion of cereals to oilcakes are kept.

(2) 100 lb. Kibbled beans
100 lb. Oats
20 lb. Seaweed meal.

100 *lb. contains;*

60·5 starch equivalent; 13·3 digestible protein; 86 lb. dry matter.

2 *lb. contains;*

1·2 lb. starch equivalent; 0·26 lb. digestible protein; 1·7 lb. dry matter.

Any legume seed can be used to replace the beans and any cereal to replace the oats; or a mixture of pulses to replace beans and a mixture of cereals to replace oats.

(3) A winter mixture which is not very palatable but may be rendered more so by mixing it with chopped roots or soaked beet pulp immediately before feeding. Alternatively the constituents can be fed separately, the dried grass unground.

100 lb. Oats
100 lb. Grass meal.

100 *lb. contains;*

62·1 starch equivalent; 12·3 digestible protein; 88·8 lb. dry matter.

2 *lb. contains;*

1·25 lb. starch equivalent; 0·25 lb. digestible protein; 1·8 lb. dry matter.

Any dried leaf may be substituted for the dried grass if the ration is increased to 2½ lb.; dried comfrey can be substituted without altering the quantity of the ration. Any cereal or mixture of cereals may replace the oats.

(4) A special purpose mixture with a high mineral and vitamin content and a lower concentration, designed for feeding to dry stock,

kids and any goat suffering from the effects or after effects of worm infestation. It is reasonably cheap.

100 lb. Bran
100 lb. Sugar-beet pulp (dry)
100 lb. Maize (cornflour residue) meal
(e.g. 'Paisley' meal)
30 lb. Seaweed meal.

Contains per ration of $2\frac{1}{2}$ lb.;

1·44 lb. starch equivalent; 0·26 lb. digestible protein; 2·2 lb. dry matter.

Wheat-germ meal may replace tbe maize residue meal. Lucerne meal may replace the beet pulp.

Bulk diets are highly depeodent oo the resources of the goat-keeper. Those bere suggested are intended to be typical of a raoge of conditioos, and for botb summer and winter; the constituents of each diet are also chosen because there is some iodicatioo available os to their food value and mineral status. For maoy goat foods there ore no scientific data available.

Bulk Diet (1) is the classic wioter ration of the high-yieldiog goat; it is not recommeoded, but under some systems of management it is inevitable; it caonot be balanced by any of the mixtures given obove, nor by aoy proprietary compound, unless the concentrates ore fed at a higher level than 2 lb. per day. But it can be balanced by omitting the seaweed meal from mixtures (1) and (2) and adding 1 per cent of fish meal—i.e. a dessertspoonful to the 2 lb. ration. Otherwise it is liable to cause breeding troubles (see p. 184).

5 lb. Legume hay
3 lb. Sugar-beet pulp
5 lb. Kale.

It contoins;

3·7 lb. stareh equivalent; 0·72 lb. digestible protein; 7·6 lb. dry matter.

With concentrate mixture (1) or (2) it provides:
5 lb. starch equivalent; 1 lb. digestible protein; 9·3 lb. dry matter, which is adequate for a goat giving up to a gallon a day.

Bulk Diet (2) is a generally applicable winter ration of hay, roots and the proceeds of foraging for natural roughage in winter time. As shown here, it is deficient in lime to a small extent when used in

conjunction with concentrate mixtures (1), (2) and (4). With mixture (3), or in a hard-winter district, or if foraging time is more than an hour or so and the forage fairly plentiful, it is adequate. Otherwise the addition of an extra 3 oz. seaweed meal to the concentrates will put matters right.

4 lb. Meadow hay (fair only)
10 lb. Fodder beet
2 lb. Heather tips.

It contains;
2·84 lb. starch equivalent; 0·25 lb. digestible protein; 6·3 lb. dry matter. In conjunction with any of the concentrate mixtures it provides for a yield of up to 6 pints.

Bulk Diet (3) is applicable only where the goats have extensive free range over scrub, woodland or moorland, and dispenses with hand feeding of bulk foods in winter. It works perfectly well in suitable country with two provisos: (a) that it is used in conjunction with a concentrate mixture of the type shown in (4)—that is, a rather bulky concentrate ration; (b) if hay or other hand-fed roughage is available for really stormy days. Otherwise there is the risk of chills and indigestion, when a cold goat who hasn't a good store of roughage inside her eats a quantity of concentrates. The concentrates should be fed only when the goat is full of roughage.

5 lb. Tree bark
5 lb. Heather tips

gives 2·3 lb. starch equivalent; 0·15 lb. digestible protein; 5·9 lb. dry matter; with the concentrate mixture it is adequate for yields up to 4½ pints.

Bulk Diet (4) is the summer diet of the high-yielding goat on the high lime-heavy concentrate system. It is very expensive but easier to balance than the winter diet (Bulk Diet 1) because in summer young growing legumes contain a fair proportion of phosphorus which is lost in hay-making. For this reason the minor symptoms of 'high-calcium' phosphorus deficiency (stiffness and limping due to the lack of phosphorus to release food energy into the muscles) usually clear up in summer.

20 lb. Lucerne
3 lb. Clover hay
5 lb. Tree leaves

provide 3·65 starch equivalent; 0·92 lb. digestible protein; 8·5 lb. dry matter; with the 2 lb. of concentrate they give: 5·0 lb. starch equivalent; 1·18 lb. digestible protein; 10·2 lb. dry matter.

This diet is not indicative of the capacity of a heavy milker but as shown, it will support yields up to 9 pints. It is noteworthy that as with all summer bulk diets, there is ample protein for higher production but not enough starch equivalent. The starch equivalent must come off the goat's back. In the winter diets allowance was made for putting it there. Which all goes to show that feeding in accordance with the glandular system of the goat is also feeding in accordance with the changing composition of available fodder.

Bulk Diet (5) is the typical diet of the goat on restricted range. It is to be sincerely hoped that the goat is allowed to get some such proportion of the gorse and tree leaves here listed, or their equivalent in deep rooting and harder forage; grass is not a balanced diet for the goat; the better the grass the worse the balance; the lack of bulk and fibre and the low mineral status relative to its digestible nutrients are equally dangerous.

20 lb. Pasture grass
5 lb. Tree leaves
5 lb. Gorse

give 3·84 lb. starch equivalent; 1·07 lb. digestible protein and 7·6 lb. dry matter. With the concentrate ration these provide for 10 pints of milk and leave some room for more in a good-sized goat.

Bulk Diet (6) is appropriate to the goats on extensive free range—not to be confused with those sharing a fair-sized paddock with a Shetland pony, who are catered for in (5) above. It is the cheapest diet here; it should touch the heart of the hard-bitten dairy farmer, the thought of turning the following rubbish into milk:

15 lb. Tree leaves
15 lb. 'Weeds' (average of chicory, dandelions and nettles)
5 lb. Grass
5 lb. Brushwood

provide 4·05 lb. starch equivalent; 0·81 lb. digestible protein; 10·25 lb. dry matter, and the makings of 7 pints of milk, without any

concentrates. Thousands of goats either can eat more of this sort of diet or take n more favourable view of its nutrient value; they certainly produce more than 7 pints on it.

The goat's maintenance and a gallon of milk require roughly:

For Maintenance	*Production*	*Total*
1·36 starch equivalent	3·25 starch equivalent	4·61 starch equivalent
0·13 digestible protein	0·5 digestible protein	0·73 digestible protein

In calculating the milk yields supported by a diet, the milk yield supported by the digestible protein of the diet has been, in general, given. On typical autumn and winter foods this leaves a surplus of 1 lb. or more of starch equivalent per day to go on the goat's back. On typical spring and summer foods it takes about 5 oz. of starch equivalent a day off the goat's back, that is about 1¼ oz. of fat. Where the diet, e.g. legumes, is naturally unbalanced for the goat, yields have been stated more conservatively.

No mention has been made of a diet for stall feeding; the variety of materials available for the purpose is so great as to make a 'typical' stall feeding or yarding diet unattainable. But here follows a table of the nutrient value and dry-matter content of about 150 goat foods.

The table has been compiled solely for the use of goat-keepers, and not for reference for any other purpose. Faced by the fact that for only a small proportion of goat foods was a chemical analysis available, and that only for a still smaller proportion were the results of digestibility trials available, I have worked to the principle that an intelligent guess is more helpful than a stack of undigested figures. All the foods mentioned here have been chemically analysed; where the results of digestibility trials are available these have been used; otherwise I have estimated the digestible nutrients from the chemical constituents on the basis of normal theoretical expectations backed by a knowledge of what goats eat and how much they like it. For instance, digestibility trials have been carried out on poplar leaves but not on oak leaves: they are similar in starch equivalent-fibre ratio, and I have estimated the digestibility of oak leaves from that shown for poplar leaves. Tree bark has not been subjected to digestibility trials, but brushwood has. I have assumed that the carbohydrates and fibre found in the chemical analysis of tree bark are digested in the same proportions as those of brushwood have been shown to be. So tree bark turns up with a starch equivalent better

than meadow hay—which is certainly no surprise to goats, whoever else may be dubious.

The layout is designed for quick practical reference.

Build your ration on the digestible protein you need; build it of seasonable bulky foods for the most part and you will find that the starch equivalents accord with the needs of the season, giving you a surplus in winter and a small deficiency in summer. The goat's digestion works best when the starch equivalent is rather less than half the dry matter; it must not be allowed to become much more than half. Dry-matter capacity varies: 5 to 7 lb. a day, according to size of goat, is near the minimum for health and comfort. Allow a big goat with a big yield up to $10\frac{1}{2}$ lb. dry matter without question—she will probably take 12 lb. if the food is appetizing. On winter feeding 9 lb. is plenty for most goats, unless the fodder is of superlative quality. It is worth weighing your goats. Weights vary between 90 and 250 lb.; appetites and maintenance needs vary with them; to feed and breed progressively it helps to know the goat's capacity in relation to her bodyweight.

100 lb. of	*Contains:* Starch equivalent lb.	Digestible protein lb.	Dry matter lb.	*Mineral state*	*Remarks*
Tree Leaves:					
Ash	14·1	1·6	20	High lime	Very palatable, laxative
Beech	2·1	0·47	20	Medium lime	Acceptable
Elm	11·4	2·6	20	High lime	Very palatable
Horse Chestnut	8·7	2·1	20	High lime	Palatable
Mixed leaves (July)	9·0	1·47	20	High lime	Palatable
Oak	8·5	3·5	20	Medium lime	Binding, palatable
Poplar	8·2	1·4	20	High lime	Acceptable
Willow	7·6	1·9	20	High lime	Palatable
Leaves of non-legume plants:					
Artichoke tops	16·2	2·0	32	Medium lime	Palatable, fresh
Cabbage:					
(Drumhead)	6·6	1·1	11	Adequate	Acceptable
(Open-leaved)	9·5	1·8	15·3	Adequate	Palatable
Carrot tops	7·7	2·2	18·2	Medium lime	Acceptable
Chicory	5·0	0·66	11·5	Adequate	Palatable
Comfrey (Russian)	5·32	2·04	12·4	High lime	Palatable
Dandelion	7·8	1·7	14·5	High lime	Palatable
Beet tops	8·6	1·4	16·2	Medium lime	Palatable, withered

100 lb. of	*Contains:* *Starch equivalent lb.*	*Digestible protein lb.*	*Dry matter lb.*	*Mineral state*	*Remarks*
Hops	8·1	2·1	23	High lime	Palatable
Kale:					
(Thousand-headed)	10·3	1·7	15·8	Adequate	Palatable
(Marrow stem)	9·1	1·7	14·0	Med. lime	Palatable
Mangold tops	5·3	1·6	11·0	Med. lime	Palatable
Nettles	12·6	3·5	24·0	V. High lime	Palatable in seeding stage, always acceptable
Potato haulm	7·2	1·1	23·0	Med. lime	Palatable
Turnip tops	5·3	1·5	11·6	Low	Acceptable, clean
Fresh legumes in first flower:					
Alfalfa (see Lucerne)					
Alsike	6·3	2·1	15·0	High lime	Palatable
Beans	7·1	2·3	15·0	High lime	Palatable
American crimson clover	7·4	4 2	19·0	High lime	Palatable
Crimson clover	8·9	2·1	18·5	High lime	Palatable
Red clover	10·2	2·5	19·0	High lime	Palatable
White clover	8·8	2·8	18·5	High lime	Palatable
Kidney vetch	7·9	1·4	18·0	Med. lime	Palatable
Lucerne	10·3	3·1	24·0	High lime	Palatable
Peas	6·8	2·4	16·8	Med. lime	Palatable
Sainfoin	7·6	2·3	20·0	Med. lime	Palatable
Trefoil	9·1	2·4	20·0	High lime	Palatable
Vetches	7·5	2·2	17·5	Med. lime	Palatable
Flowering cereals and Grasses:					
Barley	16·1	1·5	31·4	Lime def.	Palatable
Buckwheat	8·1	1·6	16·3	Lime def.	Palatable
Maize	9·1	1·0	19 4	Lime def.	Palatable
Millet	5·4	0·7	13·0	Lime def.	Palatable
Oats	10·0	1·4	23·2	Lime def.	Palatable
Rye	11·3	2·1	23·4	Lime def.	Palatable
Ryegrass (peren'l)	10·6	1 8	24 8	Low	Acceptable
(Italian)	11·4	2·1	25·0	Low	Acceptable
Timothy	13·0	1·5	30·0	Low	Acceptable
Pasture grass:					
close grazed	14·7	4 5	20·0	Low	Acceptable if clean
rotationally grazed	14·6	3 7	20·0	Low	Acceptable
Extensive grazing	11·2	2·5	20·0	Low	Acceptable clean
Roots:					
Artichokes	16·4	1·0	20·4	Low	Acceptable, laxative
Carrots	8 8	0·8	13·0	Low	Acceptable
Fodder beet	13·0	0·8	19 3	Low	Palatable
Kohl Rabi	8·3	0·7	12 7	Low	Acceptable
Mangolds (intermediate)	6·2	0·7	12·0	Low	Palatable, not males
Parsnips	10·6	1·0	15·0	Low	Acceptable, toxic?

100 lb. of	*Contains:* *Starch equiv-alent lb.*	*Digest-ible protein lb.*	*Dry matter lb.*	*Mineral state*	*Remarks*
Potatoes	18·5	1·1	23·8	Lime def.	Palatable
Swedes	7·3	1·1	11·5	Low	Acceptable
Turnips	4·4	0·6	8·5		Edible
Silage:					
Grass	12·6	2·4	24·5	Low	Acquired taste
Kale	7·9	1·5	15·9	Med. lime	Acquired taste
Lucerne	11·1	2·8	25·0	High lime	Acquired taste
Maize	12·1	1·5	21	Lime def.	Acquired taste
Oats	8·9	1·1	23·7	Lime def.	Acquired taste
Pea haulms and pods (cannery waste)	11·6	2·0	23·6	High lime	Acquired taste
Rye	5·5	0·9	13·1	Lime def.	(Bad silage)
Vetch and oats	13·0	3·8	34·6	Adequate	Acquired taste
Natural Roughage:					
Brushwood	14·8	2·1	75	Low	Palatable
Gorse	8·9	2·2	51	Adequate	Young gorse tips are palatable and more nutritious
Heather tips	12·2	1·4	50	Med. lime	Palatable in winter
Treebark (sweet chestnut)	34	1·6	67·5	Low	Palatable, also willow, holly, elm and fruit tree
Hays:					
Barley	42·7	4·6	86	Low	Palatable
Crimson clover	33·0	8·3	83	High lime	Palatable
Red clover	38	8·5	83	High lime	Palatable
Couch grass	65	4·7	93	Low	?
Lucerne	27	9·7	83	High lime	Palatable
Meadow (poor)	22	3·4	86	Low	Edible in part
(medium)	32	3·6	85	Low	Acceptable
(good)	37	5·4	86	Low	Palatable
Moorland hay (Molinia & bent)	24·6	5·5	86	Deficient	Acceptable
Oats	34	4·4	86	Low	Palatable
Rye	44	7·3	86	Low	Palatable?
Ryegrass (peren'l)	38	6·4	86	Low	Palatable if leafy
(Italian)	44	6·9	86	Low	Wastefully used
Ryegrass & clover	30	6·2	86	Med. lime	Very wastefully used
Sainfoin	40	6·2	86	High lime	Palatable
Timothy	35	4·0	86	Low	Edible
Trefoil	37	11·8	84	Med. lime	Palatable
Vetches	32	9·4	84	High lime	Palatable
Vetches & oats	34	6·5	84	Adequate	Palatable
Wheat	40 6	3·1	86	Low	Acceptable
Dried leaves:					
Artichoke	37·3	7·6	87·5	Adequate	Palatable
Ash	62	7·0	88	High lime	Palatable (very)
Beech	8 9	2·0	84·6	Med. lime	Edible
Chicory	40	5·3	93·8	Adequate	Palatable
Comfrey	40 9	13·0	88 9	High lime	Palatable

100 lb. of	*Contains:* Starch equivalent lb.	Digestible protein lb.	Dry matter lb.	Mineral state	Remarks
Elm	50	11·6	88	High lime	Palatable (very)
Grass	65·7	16·7	90	Adequate	Palatable, unground
Horse chestnut	37·5	9·0	86	High lime	Palatable
Lucerne	44·1	11·6	91	High lime	Palatable
Nettles	46·5	12·8	88·6	High lime	Palatable
Oak	36	16	85·2	Med. lime	Palatable
Poplar	34	6·0	84	High lime	Acceptable
Willow	34	8·5	89	High lime	Palatable
Straws and chaffs:					
Barley straw	23	1·8	86	Low	Edible
Bean straw	19	2·2	86	High lime	Acceptable
Lupin (Sweet Blue)	25	2·4	87·3	High lime	Acceptable
Oat straw	20	1·7	86	Low	Acceptable
Oat chaff	20	1·0	86	Low	Acceptable
Pea straw	17	4·3	86	Low	Acceptable
Pea chaff	64·2	3·6	88	High lime	Acceptable
Fruits:					
Acorns	41·2	2·7	50	Low	Acceptable ripe
Apples	12·4	1·7	26	Low	Palatable
Ash fruits (dry)	70	6·5	85	High phosphorus	Palatable
Chestnut: (Horse)	38	2·6	50·8	Low	Acceptable
(Sweet): (shelled)	64	6·0	60	Low	Palatable
Cleavers	49	8·5	87	?	Palatable
Elm fruits (dry)	50	18·0	88	High phos.	Palatable
Hawthorn	40	0·7	30	Low	Palatable
Rose Hips	14	1·0	28	High lime	Palatable
Cereal grains:					
Barley	71·4	7·6	85	High phos.	Palatable
Maize	77·6	7·9	87	High phos.	Palatable
Oats	59·5	8·0	86·7	High phos.	Palatable
Rye	71·6	9·6	86·6	High phos.	Palatable
Wheat	71·6	10·2	86·6	High phos.	Palatable
Legume seeds:					
Beans	65·8	20·1	85·7	High phos.	Palatable
Lupins (blue)	72·1	30·3	87·3	High phos.	Acceptable
(yellow)	71·1	38·1	87·7	High phos.	Acceptable
Peas	69	19·4	86·0	High phos.	Acceptable
Oil seeds:					
Linseed	119	19·4	93	High phos.	Palatable
Sunflower	103	12·8	92·5	High phos.	Acceptable
Oil cakes:					
Cotton seed	41·6	17·8	87·9	High phos.	Palatable
Groundnut	77·5	42	89·7	High phos.	Palatable
Linseed	74	25	88·8	High phos.	Palatable
Palm kernel	73·2	17·5	89	High phos.	Palatable
Sesamum	73	40	90·7	High phos.	Palatable
Soya bean	68·9	38·8	85·5	High phos.	Palatable
Sunflower	72·5	33·6	90·5	High phos.	Palatable

100 lb. of	*Contains:* *Starch equivalent lb.*	*Digestible protein lb.*	*Dry matter lb.*	*Mineral state*	*Remarks*
Germ meal and Brans:					
Linseed bran (flax chaff)	29·8	4·8	87·3	High phos.	Edible
Maize germ meal	84·3	10·4	89·2	High phos.	Palatable
Maize bran	67·0	5·5	88·2	High phos.	Palatable
Maize gluten feed	75·6	20	89·6	High phos.	Palatable
Maize (cornflour residue) meal	72·6	17	89·8	High phos.	Palatable
Pea husk meal	64·2	3·6	87·8	Low	Palatable
Pea-pod meal (cannery waste)	54·8	9·7	90·0	High lime	Palatable
Wheat germ meal	54	20	90	High phos.	Palatable
Wheatfeed (75 per cent extraction)	49	12·2	87·0	High phos.	Acceptable
Bran	42	10·9	87·0	High phos.	Acceptable
Miscellaneous:					
Sugar-beet pulp (dry)	60·6	5·3	90	High lime	Palatable
Brewers' grains (dry)	48·3	13·0	89·7	High phos.	Acceptable
Distillers' grain (wet)	16·2	6·2	26·2	High phos.	Palatable
Seaweed meals:					
Laminaria	38·7	6·1	83·7	High lime	Palatable
Fucus	37·0	—	88·7	High lime	Palatable
Milk (whole)	18·1	3·0	12·8	Adequate	Palatable
(skim)	8·1	3·0	9·2	Adequate	Palatable

A NOTE ON SEAWEED MEALS

The analysis of any brand of seaweed meal varies with the types of seaweed composing it and the time and place of harvesting. Three main types of seaweed are used: knobbed wrack (the most commonly used), tangle and bladderwrack. A full typical analysis of each is given below, along with the advertised analysis of a 'Natural Mineral Mixture', based on seaweed meals, but utterly different from them in mineral balance. References to seaweed meal in this book do not include such mixtures.

Composition per cent	*Knobbed Wrack (Ascophyllum)*	*Tangle (Laminaria)*	*Bladderwrack (Fucus)*	*'Natural Mineral Mixture'*
Digestible protein	6·82	6·1	0	9·82
Carbohydrates	58·09	45·8	53·6	56·08
Fibre	4·5	8·6	9·4	4·2
Ether extract	2·26	1·1	4·2	2·4
Ash	18·85	16·8	16·3	16·82
Moisture	9·48	16·3	11·3	10 68
Sand	1·48	?	?	1·02
Calcium	1·49	4·62	1·60	1·29
Phosphorus	0·12	0·21	0 11	0·82 (n.b.)
Magnesium	0·71	?	?	1·30
Sodium	1·97	?	?	1·17
Potassium	2·50	1·25	1·80	2·87
Chlorine	1·11	0 69	1·32	0·91
Iodine	0·07	?	?	0·16
Cobalt	trace	trace	trace	0·11

Chapter 9

SELECTION OF BREEDING STOCK

Tbis cbapter is intended to serve the needs of tbe person who wishes to produce goats' milk in quantities, great or small, and not those of the pedigree breeder whose primary purpose is to produce stock for sale. Consequently the science of genetics is only referred to in the hroadest terms, and the availahle space is devoted to the selection and hreeding management of stock suited to specific methods of goat-dairying.

The dairy farmers' hreeding policy is to provide a regular flow of milk and an adequate supply of satisfactory young stock for herd replacement with the minimum of cost and risk. In selecting his breeding stoek he must always play safe, and resist the lure of gambling in genetics. In particular he must avoid as far as possihle the dangers of inbreeding and at the same time say farewell to his hopes of achieving perfection in his herd. For the pedigree breeder a knowledge of genetics is useful and an intimate knowledge of the strains of the breed in which he is working is essential. Goat breeds are of such recent origin that the only breed characteristies which are establisbed with any degree of uniformity are those affecting colour and appearance; inbreeding is therefore essential to the pedigree breeder wbo wished to produce a strain of distinctive character and true-hreeding potentialities. The pedigree breeder must not only take tbe risks of inhreeding to fix desired cbaracter, but must proceed to the even more expensive husiness of proving and puhlicizing the character produced; he must design his feeding and management to ensure the maximum possihle production from his goats, have their yields officially recorded and their conformation officially approved in tbe show-ring. Maximum possihle production is never most economic production; tbe pedigree breeder's overheads will usually ensure that the milk of his berd is expensive to produce. One of the main handicaps to the development of a goat-dairying industry in Britain is that far too many goat-owners accept the expensive responsihilities of the

pedigree breeder, and far too many pedigree breeders lack the stock or personal qualities to justify their status. There is a dearth of first-rate goat-dairy farmers and a surplus of second-rate stock-breeders.

The main considerations in selecting stock for milk production are their inherent milking capacity, food-intake capacity and food-to-milk conversion efficiency. The pedigree breeder generally aims to produce an animal with all these qualities developed as highly as possible. But the degree to which the dairy farmer needs each of these distinct qualities will depend upon the system under which his goats are managed. While it is not possible to discuss the special needs of every conceivable method of management, useful distinction can be made between three main types of management: i.e. Stall-feeding or Yarding, under which system the goats have most of their food cut and carried to them; Goat Farming on Improved Land, in which case the goats obtain the bulk of their ration grazing crops which have been specially grown for them and other farm stock; Free-range on Scrub and Rough-grazings, in which case the goats obtain the bulk of their ration foraging growth which would otherwise be wasted. Each of these systems of management calls for a different set of qualities in the goat who is to make the most of them.

The labour of feeding the stall-fed goat is generally the biggest item on the cost sheet, with the price of the food running it a close second. The type of goat needed is one which will produce the maximum of milk for the minimum of food and attendance. The goat's milking capacity should be high and her efficiency in converting food to milk of the very best; but there is no call here for a big food-intake capacity. The modern dairy goat has been developed to consume a prodigious daily ration of cheap roughage and convert it into milk. But roughage which is dirt cheap on the ground where it grows becomes progressively more expensive every time it is handled, and by the time it reaches the feeding-rack of the stall-fed goat it may be the dearest foodstuff, per lb., of digestible protein, fed to farm stock.

One solution to the economic problem set by the appetite of the modern dairy goat is to feed it large quantities, not of roughages but of highly digestible succulents—cultivated fodder crops—and a generous measure of concentrates. This system is as good as any for forcing yields to the maximum for official recording and is popular with pedigree breeders. For the domestic goat-keeper with a few goats, who can grow most of the special fodder crops in the garden in their spare time, it is also suitable. But the high cost of field

cultivation and handling of bulky and sappy crops is a handicap to commercial dairying.

In countries such as Italy and Spain, where commercial dairying with stall-fed goats is widely practised, the type of goat used is a small flat-sided milky creature such as the Maltese or Malaga goat (which are probably derived from the wild *Capra prisca*). These goats are fed on industrial by-products such as tomato cannery waste and olive pulp, plus a little hay and a small concentrate ration. They consume little more than half as much food in proportion to bodyweight as our leading breeds, but produce almost as much milk in proportion to bodyweight as our 200-gallon milkers. These *Capra prisca* derivatives seem adjusted to a more concentrated ration than is healthy for goats derived from the mountain goat *Capra aegagrus*. In Italy and Spain they are preferred to the available alternative type with bigger food capacity and higher yields per head, because they save labour and are more economic, even at Spanish wage rates.

There are several British industries at present pouring their edible wastes into rivers, pig troughs and sewage pipes which might support stall-fed goat dairies. Though they do not appear in the show-ring or the leading pedigree herds, there are a number of flat-sided goats with small food capacity and good milking abilities. The true *Capra prisca* type (Plate 30), with a short straight, twisted horn, are rare.

Whether we adopt the fodder crop or the industrial waste as a basis of feeding for stall-fed or yarded goats, we are adopting a very *wet* diet; this is an essential to maximum production from a given quantity of nutrients. The goat which will make the best use of such a diet is not the one who has the biggest capacity for bulk, but the one with maximum capacity for slop—that is, a goat that is deep but not wide in the body.

It is also interesting to note that the goats used for commercial dairying on the stall-feeding system in the Mediterranean basin are long-haired. On the other hand, the free-range foragers, even in mountainous districts, are preferred short-coated, like the Murcian and Granada goats of Spain. Goats derive their heat mainly from the bacterial fermentation of roughage, and on a concentrated diet are more subject to chills, even when housed, than when full of fibrous forage on the bleakest mountain-top. Our stall-fed goats are often insulated from the cold by flannel coats or a layer of subcutaneous fat; flannel coats are less fool-proof and fat is more expensive than long hair, which can always be clipped away from the udder for the sake of dairy hygiene.

The goat farmer on improved land has need of quite another kind of goat. His labour costs are largely concerned in the organization of controlled grazing; his food costs are moderate. The fewer goats he has to control the better; the more forage crop they will eat the less they will need out of the bag of expensive concentrates. He needs goats with as high a milking potential as possible, and a good food-intake capacity. A very high food-to-milk conversion efficiency is not always desirable; fodder crops are succulent rather than fibrous, and the British climate is notorious. Goats grazing improved land will resist chilling and feed in worse weather if they carry a little fat or a coat of long hair (the flannel substitute is unsatisfactory out of doors, especially in the rain). The weight of a big udder, a well-filled and capacious paunch and a rather fat body are most easily carried on short sturdy legs. Ground clearance for the udder is of little account in cultivated fields, but the udder requires to be exceptionally well hung, broad in the base and close to the body to avoid the dangers of chilling.

The leading breeders produce excellent stock for this purpose.

Goats that have free range on rough grazings are consuming food that costs next to nothing; the more they eat of it and the more efficiently they convert it to milk the better. Big food capacity is of prime importance. Such goats consume ample fibre to keep themselves warm and have no need of a quilt of fat or long hair, so their food-to-milk conversion efficiency may be very high. But very great milking capacity is not wanted. Any advantage to be gained from a superlative yield is more than cancelled out by the large proportion of concentrate necessary to maintain it, the burden of carrying an unwieldy udder over rough ground, and the damage that udder will suffer from the brambles and hazards of a typical rough grazing. Long legs are needed to give the udder ground clearance and are an important asset to a forager among trees and shrubs. The quality and hang of the udder is not a matter of primary importance. As a free-range goat farmer the writer has happiest memories of some tough, pendulous bags, with skin like crêpe rubber, impervious alike to knocks, scratches and climate. The classic peach-skinned vessel, delectable to handle and easy on the eye, is so firmly attached that it is the loser in every encounter; after a day on range its tenderness may make more difficulties for the milker than a more unsightly and tougher bag.

The amount of damage that the udder of a heavy milking goat receives, while on range among scrub and rock, depends to some

extent on the general conformation of the goat. This matter has received less attention than it deserves from our breeders. Viewed from the side, most of our goats show an almost horizontal top-line, from the shoulders to the rump; if anything the shoulders are a little higher than the top of the rump; the under-line slopes steeply down from the chest to the udder. This conformation gives the goat, in appearance and reality, perfect balance and control on steep slopes; it is typical of mountain goats the world over and has been impressed on our stock by the influence of the Swiss breeds. Goats adapted to scrubland, as opposed to mountain, pastures have a different shape; the top-line slopes quite steeply up from the shoulders to the top of the rump, and the under-line is roughly horizontal from the top of the udder to the chest. This conformation gives better ground clearance to the udder, the weight of the udder is more equitably shared between fore and hind legs and the extra long hind legs give the goat a higher reach when browsing. It is exemplified in the heavy milking Murcian goat of Spain, in the little scrub goats of Galicia and in many of the Oriental breeds. Of home-made breeds the Anglo-Nubian possesses this character, a legacy from its desert ancestors, and the British Alpine shows the character to a rather smaller extent.

Where goats have a very extensive range it is a matter of importance that their herdsman should be able to see them at a distance. The camouflage markings of the Toggenburg and British Alpine are a negation of utility in this respect, and the nondescript colouring of the Anglo-Nubian is little better. Pure white or unbroken black are the colours most easily spotted at a distance. Those who doubt the visibility of black should ask a hill shepherd the colour of his dog.

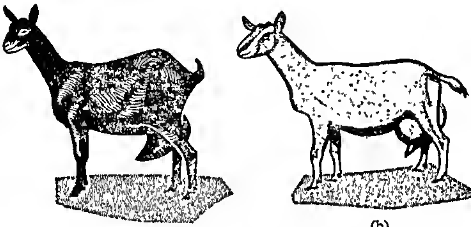
There are seven recognized breeds of goats in Britain:*

(1) *The Saanen*—nominally of Swiss origin, goats of this breed are all descended from imported stock, the majority of which came from the flat fields of Holland. White in colour, placid in disposition, rather short in the leg and capable of the very highest yields, this breed is well suited to goat farming on improved land. The labour involved in avoiding unsightly staining of the white coat is a disadvantage if the breed is kept under intensive conditions where the goats spend much of their time lying on their own droppings and urine. White-skinned Saanens develop skin cancer in sunny climates; dark-skinned, but white-haired, goats are immune. Short legs and big udders associate badly with the brambles and hazards of a rough

* Plus the old English and the Nubian, recognized but extinct.

grazing. Udders in this breed are usually shapely and well hung. Butter-fat percentages are good—around 4 per cent.

(2) *The British Saanen*—of mixed origin, is usually a considerably heavier and slightly leggier goat than the pure Saanen, but otherwise similar. Udders are less shapely on the whole and yields as high as any. Like the Saanen and for similar reasons it is best adapted to goat farming on improved land, where the tendency of some strains to run to fat does not go amiss.



(a) (b)

Fig. 19 (a). The Murcian Goat has a scrubland shape; (b) the Toggenburg Goat has the mountain shape

(3) *The Toggenburg*—descended from imported Swiss stock, is numerically the weakest of the recognized breeds and progress with the breed in this country is hampered by lack of numbers and in-breeding. Brown and white in colour, with an active but affectionate disposition, the Toggenburg is a small goat, usually under 100 lb. adult weight. Yields are low, seldom exceeding 200 gallons per annum, with the butter-fat percentages of well-fed specimens deplorably low at under 3 per cent. Udders are usually well hung. Not every household requires 200 gallons of milk a year. As a stall-fed household goat the Toggenburg has the advantage of requiring less food than most, and its brown coat resists staining. As a free-range rough grazer the Toggenburg is in its traditional environment, and on a lower level of nutrition the butter-fat content of its milk is not so outstandingly bad. There is a good demand for pedigree stock for export.

(4) *The British Toggenburg*—of mixed origin, carries a large proportion of Toggenburg blood which is needed to fix the rather elusive

Toggenburg colour and markings. But it is a big ten-stone goat, giving notably high yields of milk with a butter-fat percentage around 3·5. The high metabolic rate necessary for heavy production superimposed on the warm-hearted Toggenburg disposition tends to make the breed remarkably excitable. Though this may be a slight disadvantage in a strictly commercial herd, it makes the 'B.T.' the most responsive pet in the goat world. The relatively stain-proof coat is an added advantage under intensive conditions. Long legs, high-geared temperament and big food capacity suit the breed for free range on rough grazings, but badly hung udders are a common fault. As the B.T. is restrained with more difficulty than other breeds and its rather low butter-fats are further lowered by soft rich feeding, it is not the obvious choice for goat dairying on improved land.

(5) *The British Alpine*—shares much ancestry with the British Toggenburg, but is black with white Swiss markings; a big leggy goat, turning the scale around ten stone, it is capable of high yields, with a butter-fat percentage about 4 per cent. It is the only British-made breed to have been developed mainly under free-range conditions and has an independence of character which would be better appreciated if there were more men farming goats and fewer women keeping them as pets. Under intensive conditions the B.A. is almost as easy to keep clean and as efficient a producer as the British Toggenburg, but a duller companion. For arable dairying it is rather less easy to control than the Saanen or British Saanen, is relatively free from the tendency to run to fat, but unwieldy udders are not uncommon in the breed and give rise to trouble under these conditions. The black coat attracts flies, which is a handicap in closely wooded country. It remains the most adaptable all-round breed and could be developed into a first-rate goat for scrub dairying with less difficulty than any other.

(6) *The Anglo-Nubian*—of mixed origin, owes its distinctive features to imported goats of Indian Jumna Pari and Egyptian Zariby type. Undoubtedly the most important British contribution to world goat-breeding, the Anglo-Nubian is the most distinctive of our recognized breeds in both appearance and performance. Colours are various with roan and white predominating, lop ears and roman nose are typical. It is more heavily fleshed than the Swiss breeds, weighing about 150 lb., gives yields comparable with the Toggenburg in quantity (up to 300 gallons a year), but with a butter-fat percentage around 5 and a percentage of solids not fat of 10 to 11, compared with the 8 to 9 of other breeds. The rich milk characteristics of the flat-sided goats of the sub-tropics are here blended with the great fodder capa-

city of the Swiss breeds to make an economic producer of what is perhaps the most highly digestible and perfectly balanced food available to mankind.

The udder of the Anglo-Nubian, though not remarkable for its shapeliness, has a better ground clearance than that prevailing in other breeds. Though the coat is short, beneath it lies an insulating layer of subcutaneous fat which enables the goat to withstand adverse weather as well as most other breeds. It is excellently suited to free-range goat farming, or to arable dairying, under which conditions it can produce milk *solids* as economically as any. But being an inefficient producer of milk *water*, unless an exceptionally discerning human consumption market will pay a premium for its quality, Anglo-Nubian milk is best cashed when fed to stock. As a house goat the Anglo-Nubian has the disadvantage of being exceptionally vocal; but its milk is undoubtedly the most desirable of any.

(7) *British*. In this section of the B.G.S. *Herd Book* are registered pedigree cross-breeds. The arrangement is almost unique in British stock-breeding, but exceedingly useful; the hybrid poultry breeders and the pig breeders have found the need for a similar arrangement but recently. To the goat-breeder it provides a useful pool of genetical characteristics on which to draw for the improvement of existing breeds and the development of new ones, and it gives guidance in cross-breeding for maximum production. The section contains many of the heaviest milkers in the country.

The cow dairy farmer who decides to stock his farm with, say, Jerseys, and obtains his foundation stock from a number of different breeders, will find himself with a reasonably uniform herd. But the goat dairyman who stocks with, say, British Saanens, obtained from various sources, is likely to accumulate a herd of goats of all shapes and sizes and characteristics, though almost all of them would be white in colour. While the breeds do have distinctive utility characteristics, to obtain a reasonably uniform herd it is necessary to select from within the chosen breed the strains and individuals of the desired type.

Some of the utility characteristics: udder shape, long legs, coat quality, degree of fatness, declare themselves openly to eye and touch. To discern the outward and visible signs of the hidden qualities that make an efficient milker is the main task of the show judge and the necessary knowledge cannot be compressed into a paragraph.

But as a coarse pointer: if you want great milking capacity, look for a long lean head, interested eyes, and lively movements, a long

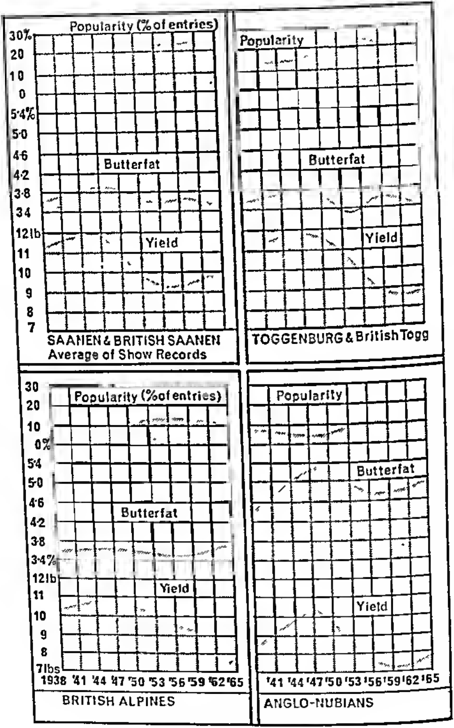


Fig. 20. Breed Profiles

slim neck and gently sloping rump; fecl fnr a fine pliable skin with a smooth and lustrnus cnat, for a large elastic udder and knnbbly milk veins; if pnssible, cnnsult the milk records nf the gnat nr ber dam and sire's dam.

Fnnd capacity is largely a matter of sheer size, with particular empbasis nn the depth aad width and spread nf the ribs and the develnpment nf a deep wedge-sbaped prnfile; but a nervnus fidgety gnat eats mnre than a placid nne. Mnst gnats that sag in the middle cannnt carry a great lnad nf fndder nver rnugh grazings—but Angln-Nubians have their legs mnre widely set than tbe nther breeds and, like a suspensinn bridge, they are designed tn sag. A lnng jaw is a help tn a big appetite and lnng legs tn a consumer nf branches.

Fond conversion efficiency can be measured only apprnximately by the eye, being lowest in the short, thick fat goat and highest in the long, lean glossy one. Gnats carry their basic fat deposit on the chest and ns a quilt nver tbe belly. If your fingers find fat on the back and rump of a milker the milk-pail is being robbed to clothe tbe goat—but on goatlings and kids back fat is a reserve fnr their first lactation. In assessing the goat's tendency to fat it should always be remembered that a dry diet with n restricted nr unappetizing water supply will fatten any goat, while the nutrients that accompany a big fluid intake always tend towards the milk-pail.

The detection of these basic utility qualities in tbe genetic make-up of tbe male goat is nnt a suitable task for the eye and hand of inspection—nnt even if the eye and hand be those of an expert. In selecting a herd sire, his prngeny are the nnly reliable guide to his quality; his pedigree may give grnuads fnr reasnnable hnpe.

While his skin quality, cbaracter nnd cnnfnrmatinn have n similar significance to the parallel qualities in the female, their appearance in the male gnat may be easily confnunded by secnndary sexual characteristics and accidents nf rearing.

The operatinn nf the scent glaads nn the he-gnat's skin nnd his habit nf spraying his front legs nnd neck occasinnally set up in the housed billy a kind nf dermatitis which converts a naturally snft and pliable skin intn hairless corrugated leather (see 'Scab', p. 263). The practice nf feeding male kids large quantities nf milk until they are far past the natural weaning age is liable tn result in a distnrted grnwth—great length and bone and great depth due to the sag of the milk-filled stomachs, but far less width and spread of rib than that tn which his inheritance entitles *him*. The need under common circumstances tn keep the males in a small enclnsure and carry their fodder

to them, may lead to them receiving a rather concentrated ration, which accentuates the appearance of narrowness without in any way affecting what inherited capacity they may have for breeding wide-ribbed kids.

There are also certain characteristics that may be required of the herd sire, but are not particularly wanted in the milkers. Exceptional docility, for example, is in common demand. A well-exercised he-

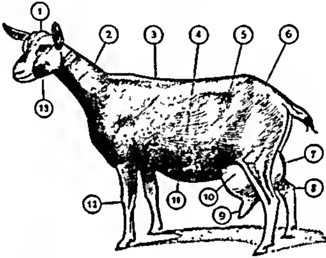


Fig. 21. Points of the productive goat

(1) Long lean head with lively expression.
(2) Long, lean silky-skinned neck.
(3) Strong, straight muscular back.
(4) Deep wide-sprung ribs, the last rib curving back.
(5) The hollow in front of the hips that bespeaks the capacity of the digestive organs.
(6) The long gently sloping rump to support a heavy vessel.
(7) The capacious vessel, broadly based on the body and with fine elastic skin, swells the rear profile.
(8) The hocks are sufficiently straight to avoid bruising the vessels when the goat walks.
(9) The teats are hand sized and distinct from the rest of the vessel; the thicker they are the quicker she will be to milk.
(10) The extension of the vessel forward is the goat's safeguard against udder chills.
(11) Under the belly you can feel, if not always see, the big knobbly milk veins.
(12) Strong clean bone in the front legs.
(13) A long powerful jaw to match a big appetite.

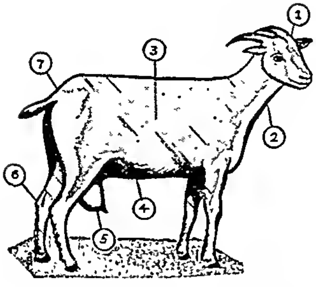


Fig. 22. The unproductive goat

(1) Has a short convex face and a more or less upturned nose.
(2) A short coarse neck.
(3) Shallow straight ribs and a brick-shaped profile.
(4) A small belly.
(5) Small tough-skinned vessel, purse shaped with little finger-breadth teats.
(6) Her hocks nearly knock together as she walks.
(7) Her rump is short and steep.

She is dear as a present to 'a good bome', unless she goes straight into the pot.

goat, accustomed to kiadly but firm control, is not a dangerous beast. But if chained and penaed for life and handled with some fear and disgust, any but the poorest in spirit becomes unmaaageable. Though a very soft-tempered male seldom breeds outstanding milkers, or a temperament suited to free-range life, poor-spirited and effeminate billies are justifiably popular with those who lack the facilities for keeping a more vigorous beast under control. The Saanen breed generally produces the quietest males, and the fleshier strains of British Saanen are usually temperate in habit.

The odour of billy is universally unpopular, a menace to the production of palatable milk, and an all-round nuisance. Its seasonal production is a secondary sexual characteristic of the goats of cool regions, in which there is a limited breeding season. In tropical countries where the male remains sexually potent all year round, scentless males are not uncommon and the odour of the odoriferous is milder. The tropical ancestry of the Anglo-Nubian has resulted in some

strains of the breed producing very mildly scented males and there seems to be no theoretical reason why this highly desirable characteristic should not be further propagated. Effeminate males of other breeds are often mildly scented too, but in the Swiss breeds such males frequently prove unsatisfactory breeders.

The smell of billy is a real problem of practical importance which tends to get overlooked because it is also a joke. Contamination of the clothing of the billy's attendant is unavoidable, and the regular attendant becomes inured and insensitive to the smell after some months. But whenever contaminated clothing comes within range of the public's nostrils or an open can of milk, damage is done to the goats' milk industry. It is an elementary precaution to handle the billy and milk the goats in distinctively different overalls; clothing can be fairly effectively decontaminated by hanging it in acrid smoke such as is produced by smouldering oak sawdust or by the bee-smoker's corrugated cardboard. A new and radical solution of the problem is offered at the end of Chapter 10.

In many free-range herds the male runs out with the rest of the flock at least during the summer. Special considerations arise in selecting a male for this routine. Under such natural conditions the social structure of the wild goat flock is resurrected and the male leads and controls the flock's grazing if he is able to, especially during spring and early summer. In the wild herd the he-goat's size and his ever-growing hair and horns call for a supply of nutrients and minerals which differs little from the requirements of the milkers. The short-haired hornless sire of the domesticated herd has needs insignificant in comparison with those of high-yielding milkers and his leadership of the foraging expedition is sheer misguidance. Where the flock and range is small this misguidance results in lowered condition and yield; where the flock is large and the range extensive it results in a splitting of the herd on range, the milkers generally following a leading she-goat and the dry stock following the billy; this division of the flock multiplies the problems of control and management. But the problem is minimized by insisting that the male who joins the flock on free range is always a young one. The he-goat goes on growing until he is two and a half years old; so long as he is fleshing a large and growing frame his dietetic needs are not so far below those of the milkers; until he is old enough to throw his weight around effectively, his efforts to misguide the flock will be thwarted by the leading milker.

Under few circumstances are horns desirable either in the male or

his progeny. Only when goats are closely confined or tethered in places liable to regular invasion by small boys and uncontrolled dogs may the balance of advantage lie with the horned goat. Not that horns are dangerous to the goats' attendant; indeed they provide useful handles. But they are very dangerous indeed to the udders of other goats and a tragedy is ultimately inevitable where horned goats are run together, and more speedily inevitable where horned and hornless goats associate. The use of a disbudded or de-horned male is often advisable, but only if every horned kid is disbudded.

By far the most satisfactory male for any goat dairy farmer (as opposed to pedigree breeder) to select, is the one standing at stud within a reasonable distance of the farm. The dairy farmer is justified in turning a blind eye to considerable defects in any billy he can use but is not called upon to keep.

Artificial insemination of goats has been practised in the Soviet Uninn, in India, Denmark and France. In Denmark, the goat-breeders inseminated their own goats with semen expertly collected. This scheme achieved up to 80 per cent of successful inseminations, the best results for any A.I. service for goats; but it was destroyed by the Danish Government withdrawing their very modest financial support, as a national economy measure.

In France, a state-sponsored insemination service is available in the main goat-breeding areas. Semen is collected as for cattle, diluted to one-quarter of its original concentration, chilled to 3° C., and stored up to 24 hours. Insemination is carried out by trained staff, using the same techniques as for cattle. Sixty per cent of inseminations are successful; as far as possible, goats are inseminated 12 hours after the first appearance of 'season', this stage having proved the most favourable. *The French find a 35-per-cent variation in the ferti*lity rate between males, even though the sperm count and motility be comparable. This rather mysterious male fertility factor, and the difficulty in maintaining the potency of goat semen over long storage periods, seem to be the main technical difficulties. As such they are no impediment to a practicable and economic A.I. service for goats.

As a means of stock improvement, A.I. is not of immediate importance in Britain. Improvement of productivity by genetic means proceeds at the rate of about 1 per cent per generation, under good genetic management. Improved kid-rearing and goat-feeding methods could probably raise productivity 20 per cent in one generation.

Chapter 10

BREEDING PROBLEMS

The demands that mankind makes of the goat have not required any fundamental alteration of its breeding mechanism nor distortion of its shape and proportions. In this respect the goat is a great deal more fortunate than its comrades of the farmyard, and consequently remains relatively free from breeding troubles.

The naturally early maturity and high fecundity of the goat is adequate to meet any normal demand for the maintenance or increase of stocks. The problem of winter milk supply is solved by allowing the goat to go wild or 'run through' alternate years and run a twenty-two-month lactation as a matter of course. Even on this routine an average goat in a cool climate will produce five daughters in eight years—if a dairy cow produces five daughters in a lifetime she is doing well. Consequently, out-of-season breeding with goats has nothing like the utility value of the relative freedom from breeding troubles they enjoy, by retaining their natural sexual cycle and glandular rhythm.

The mechanism which controls the breeding cycle of cows is understood to a limited extent. It is possible, with the hand in the cow's rectum, to feel the whole of the genital organs and the changes that take place in them. The mechanism controlling the breeding cycle in goats is believed to be similar, but the belief cannot be so tangibly confirmed.

The sexual cycle is started by the anterior lobe of the pituitary gland (the 'master gland' below the brain) secreting 'F.S.H.' (follicle-stimulating hormone), a substance that excites the ovaries, at each tip of the horns of the womb, to develop a blister, inside which one of the store of eggs in the ovary rapidly develops. This blister itself secretes 'oestrogen', a substance that produces the symptoms of oestrus (heat). The womb contracts, the cervix at the mouth of the womb relaxes and opens, the vagina is tensed and lubricated by the discharge of slime. The goat becomes restless, bleating and wagging

its tail, with a red and swollen vulva often showing some of the discharge. Vagina and womb are prepared for the entrance of the male sperms and the goat will 'stand' to the billy.

When the blister in the ovaries reaches its full size, the pituitary produces 'L.H.' (luteinizing hormone), causing the blister to burst and the mature egg to start on its passage down the long, twisted fallopian tubes which join the ovaries to each horn of the womb. The broken walls of the blister then grow 'lutein', a kind of temporary gland that secretes 'progesterone', a substance having the opposite effect to that of oestrogen. The outward symptoms of 'heat' subside, the vagina relaxes and dries, the cervix closes to seal the womb, and the womb relaxes and is richly supplied with blood. If service has been effected, the egg on its passage down the fallopian tubes encounters a sperm and is fertilized; arriving in the womb it finds the place prepared for it by the action of progesterone, settles down and develops. The lutein remains, continuing to secrete progesterone until the foetus is mature. Then the lutein is reabsorbed, and, at the stimulus of the pituitary, the ovaries once more secrete oestrogen, which relaxes the cervix, lubricates the vagina and contracts the womb to expel the kid, at the same time inducing the restlessness and often the other symptoms of heat in the goat's behaviour. When the kid is born, the secretion of oestrogen ceases.

If the egg is not fertilized in its passage down the fallopian tubes, the lutein persists, secreting progesterone, for about ten days; then it shrinks away and F.S.H. is again secreted by the pituitary to start the cycle over again.

What stimulates the pituitary to start the whole process is obscure. But the main function of the pituitary in this matter is to ensure that kids are born only if and when conditions are suitable for their survival. Under tropical conditions where seasonal changes of climate and vegetation are immaterial, the goats' breeding season extends over the twelve months of the year; lactations are short where Nature provides abundant food for early weaning and two or more pregnancies a year are normal. Normal health is the only stimulus needed to maintain the cycle. Farther from the Equator seasons become more pronounced. Generally speaking, in the northern hemisphere to which the goat is native, the spring months of April and May offer the kid the most auspicious welcome. As the goat, like the sheep, carries its young for five months, the months of October and November are ideal for starting the breeding season. Various factors signify the arrival of these months: diminishing

length of day, falling temperatures, herbage growing drier and tougher. Each of these factors plays its part in stimulating the onset of the breeding season. In Kenya where the length of day does not change but there are two periods of rain each year, followed by lush growth and drought, the hardening of the herbage with the drought starts the breeding season and the kids are born after the rains; so there are two breeding seasons a year. Farther north, and throughout Europe, the dominant factor in the onset of the breeding season is the diminishing length of day.

Our goats are derived from a wild stock native to the Mediterranean basin and their glandular control is still designed to produce kids in April and May in these latitudes. The onset of the breeding season in southern France and the Balkans is in mid-October and the kids arrive in April. But the critical rate of change in the length of the day takes place closer to midsummer the nearer we go towards the North Pole. In the extreme north of Scotland the length of the day is diminishing as rapidly at the end of July as it is in mid-October in Marseilles. Consequently, the goat's breeding season in the north of Scotland starts at a time of year which results in the production of kids in the first days of January, and a very cold welcome they get. Scotland can always be relied on to supply England with early kidders. The incidence of the breeding season throughout Britain is shown in Fig. 23. The dates refer to the effect of the diminishing daylight factor. They may be considerably modified by weather or management which alters the apparent length of day, and slightly altered by diet and by inherited propensity for early or late kidding in individual goats.

By the injection of hormones it is possible to extend the kidding season still further. P.M.S. (pregnant mare serum) causes ovulation; progesterone conditions the womb to accept the fertilized ovum. The best subject for the treatment is a goat who has kidded at least four months previously. On Monday give her a subcutaneous injection of 50 mg. progesterone in oil of arachis; repeat on the following Thursday, and again on the next Monday. On the Thursday after that give her an injection of 750 international units of P.M.S. She will come into season during the following week-end. Male fertility is lowered out of the natural breeding season, but is usually adequate for an isolated occasion. (Artificial insemination may be more reliable.)

For three weeks after mating the fertilized egg lies free in the uterus, nourished by a secretion of the uterine glands. After three weeks the outer, 'trophoblast', layer of the developing egg eats into

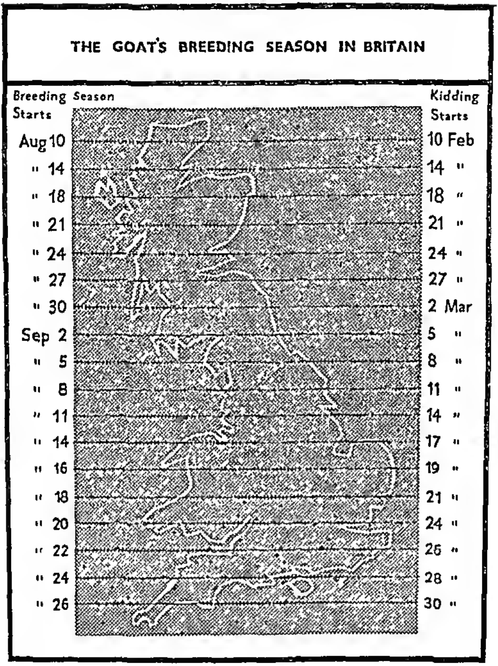


Fig. 23

the mother's tissues and forms an attachment—the placenta. For the next ten weeks the trophoblast cells act like a sort of cancer, extracting all the needs of the growing embryo from the mother's tissues, whether she can spare them or not. Level of feeding of the mother during this period has no effect whatever on the growth of the embryo,

which extends its attachment to cover the area of uterus wall available. Then, eight weeks before kidding, the trophoblast cells die off, and the foetus is fed by transfusion from its mother's blood-stream into its own. The quantity of transfusion depends on the area of the placental attachment, which will be less than the optimum when the goat is too small, or too fat, or carrying too many kids for her size. The quality of the transfusion the foetus receives will depend on the current diet of the mother and her metabolizable body reserves.*

The end product of the sexual cycle is not only the kid, but lactation. A number of different hormones control the development of the udder and the secretion of milk; the process is not yet fully understood. But it is known that both oestrogen and progesterone play a part in normal development of the udder, and that the secretion of the thyroid gland, which is poured out in increased quantities during pregnancy and spring, has the effect of diverting nutrients towards the womb and udder, thus assisting milk production. Oestrogen itself inhibits the secretion of milk, so most goats show a slight fall in yield when they come in 'heat'. But a falling level of oestrogen in the blood, such as occurs at the end of pregnancy, triggers the chemical mechanism which starts the goat milking. In barren goats, too, the level of oestrogen in the blood falls at the end of the breeding season in early spring, when the thyroid is most active; consequently they often become 'maiden' milkers.

If a valuable milker goes dry and proves obstinately barren, she can be brought into milk by injecting 0·5 mg. hexoestrol and 70 mg. progesterone in anarachis oil solution daily for 150 days. This produces a near normal yield and udder development. A dry and barren goat whose capabilities are unworthy of the expenditure of so much time and money, may be brought into milk by implanting a single caponizing pellet of hexoestrol under the loose skin of the shoulder, during late April or early May. Shortly after this painless operation the goat will show signs of 'heat' which may continue for about ten days. About five days after the operation the udder will begin to fill; if milked out regularly a useful yield, about 60 per cent of natural capacity, will be established in three to six weeks, from an udder more or less unevenly developed. The implantation of a hexoestrol caponizing pellet can be used to suspend lactation temporarily in a goat in full milk; in the case of severe injury to the udder this can be the goat's salvation. But implanting hexoestrol in a pregnant goat will probably cause abortion; and in a barren goat there is always the

* Sir John Hammond, *I.D.G.C.*, 1964.

risk that it may induce a 'cystic ovary', a state nf perpetual 'heat' and chrnnic infertility.*

The male sex organs are a little mnre complicated than nutward appearance suggests. The testicles in which the sperms are produced consist nf a numher of *minute tuhes*, cnnverging into a central tuhe. The sperms are formed in the small tubes, move intn tbe central tube and thence into the epididimis, a very lnng convoluted tube in which the sperms mature. From the epididimis they emerge intn the cord connecting the epididimis with the seminal vesicle ahove the hladder, where the sperms are diluted in the seminal fluid which activates them —the seminal fluid being produced hy a number nf contrihutory glands.

The pituitary of the male goat, like that of the female, produces both F.S.H. and L.H. The function of F.S.H. in tbe male is unknown. But L.H. stimulates the testicles to produce botb sperms and tbe hormone 'testerone', whicb gives the hilly his typically male appearance and behavinur. A deficient secretion of L.H. is symptomized by a feminine appearance, sluggish service and low fertility, and is a eondition wbich may be inherited nr result from faulty feeding.

Considering the complexity nf the processes involved, and the small amount of knowledge we bave of them, it is wonderful how seldom the mechanism goes wrong under the artificial conditions nf life and diet that we impose nn the goat.

Although the fertility of goats is occasionally impaired hy errors of diet and management, or hy disease, the main fertility trouhles are connected witb the prnhlem nf hermaphrnditism. Of all tbe aspects of goat husbandry, this prnblem nf hermaphroditism seems to he quite tbe most attractive to scientists. During the past ten years, geneticists, patbologists, and micro-binlogists from at least five different countries have puhlished papers on the suhject. Their theories remain inconclusive; but all their facts support the same practical breeding policy and are consistent witb the ecological explanation of the subject offered in the first edition of *Goat Husbandry*, ten years ago.

A hornless or 'polled' mutatinn turns up from time to time in all the horned species, cattle, deer, sheep, goats, etc. It is a tentative measure of disarmament, a saving of expense on defensive weapons; provided the defensive weapons have ceased to serve a purpose, the mutation is likely to prove successful. But in animal societies such as those of the red deer and the mountain goat, in which the males

* Benson, *B.G.S. Y.B.*, 1957.

select the pastures for the herd, and for whom the main natural enemy is starvation, though female horns be irrelevant, the annual renewal of the stag's antlers and the ever-growing burden of the male goat's horns are society's sole guarantee that the males' choice of pasture matches the needs of the mothers (see p. 214). Although the stag does not lead his family party as the male goat does, it is the summer parties of antler-growing stags that pioneer new territory for the expanding red deer herd. For both deer and goats a hornless male may be social disaster. Inevitably the hornless male will keep in better condition and be more mobile than his horned or antlered rival. During the breeding season his advantage must ensure him a disproportionate share of services; if fully fertile he must reproduce his kind to the destruction of the flock. The polled stag or 'hummel' is always to be found on the deer forest; he is to the fore at the 'rut', and more than a match for the antlered stags; yet even on the most neglected forests the percentage of hummels does not greatly increase; and on the best-managed estates, where hummels are rigorously weeded out, the proportion of hummels remains much the same.

In the hill country, one year in seven is a year of disaster, when the snow lies too deep and winter lasts too long. When the new grass starts to grow at last, it grows greenest around the corpses of the antlered stags. The hummel survives, wintering on his fat; in the autumn of that year the survival of the herd may largely depend upon such fertility as the hummel has. Mountain pastures are a delicately balanced community of plant and animal life; alter one element and the whole kaleidoscope changes; remove half the deer and the vegetation coarsens; let the vegetation grow rank and the goat moves in. A species must make a rapid recovery from disaster to retain a footing in its habitat. The hummel's fertility needs to be exceptional.

The only sort of hornless mutation which is going to succeed among mountain goats or mountain deer must satisfy two requirements; (1) under normal conditions and natural selection, the percentage of hornless males must not exceed about 5%; (2) increased use of hornless males should boost herd fertility.

The hornless mutation that has survived among domesticated goats in Europe almost certainly originated among the mountain goats of Switzerland; indeed all the investigations of the factor, in Israel, Britain, Germany and Japan, have been carried out on descendants of exported Swiss Saanens. This mutation meets the ecological requirements of the mountain-goat flock in the following way:

The factor for hornlessness is inherited as a Mendelian dominant;

if the gene is present there are no horns, if absent there are normal horns; there is no half-way stage. But hornlessness is closely linked with a factor which modifies fertility. In heterozygous form in females it causes an increase of 5 per cent in fertility by increasing the incidence of twinning and triplets; in homozygous form in females it

THE HORNED GOAT is 'Homozygous'—that is, the factor for Horns is inherited from both parents. The factor for Horns being 'recessive' would be apparently suppressed if a factor for Hornlessness were inherited from either parent. Linked to the factor for Horns is a 'dominant' factor for Normal Sexual Development. The Horned Goat passes on to all its offspring a 'recessive' factor for Horns and a 'dominant' factor for Normal Sexual Development.

THE HOMOZYGOUS HORNLESS GOAT inherits from both parents a factor for Hornlessness which is dominant, *linked with a factor which tends to change the foetus in* the womb into a male. If the foetus started male it is unaffected; if it started female it will be born apparently female, apparently male, or obviously intersex—but always sterile. The sex-change factor is 'recessive', effective only in the homozygous state. There are no Homozygous Hornless females capable of breeding, but the males pass *on the dominant Hornlessness and recessive sex-change* factor to all offspring.

THE HETEROZYGOUS HORNLESS GOAT inherits from one parent the recessive factor for Horns, linked with the dominant factor for Normal Sexual Development, and from the other parent the dominant factor for Hornlessness with the recessive factor for foetal sex-change. The goat appears Hornless and its sexual development is normal, but it can pass to its offspring a factor either for Horns or Hornlessness, each with its linked factor for normal or abnormal sexual development. All Hornless females capable of breeding are heterozygous.

HORNLESS-NESS WITHOUT HERMAPHRODITES
The Three Geno-Types

24a.

causes a partial, or apparently complete, pre-natal sex change; no true homozygous females are born, but a mixture of pseudo-females, pseudo-hermaphrodites, and pseudo-males; all, of course, hornless, and all infertile. Neither in homozygous nor heterozygous form is this factor known to affect the potency of true males, one way or the

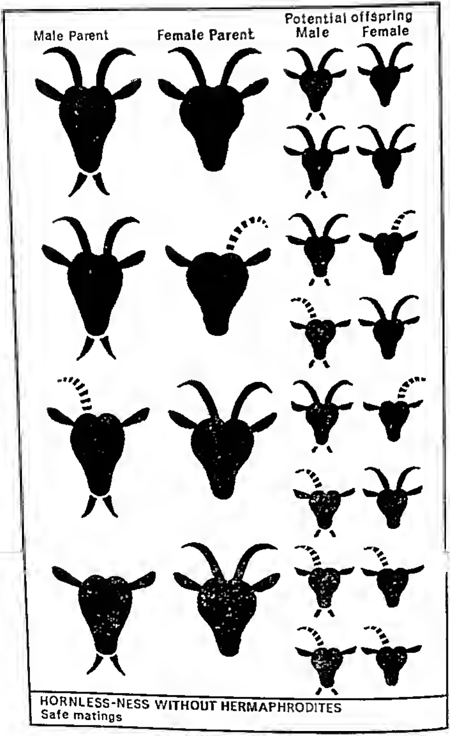
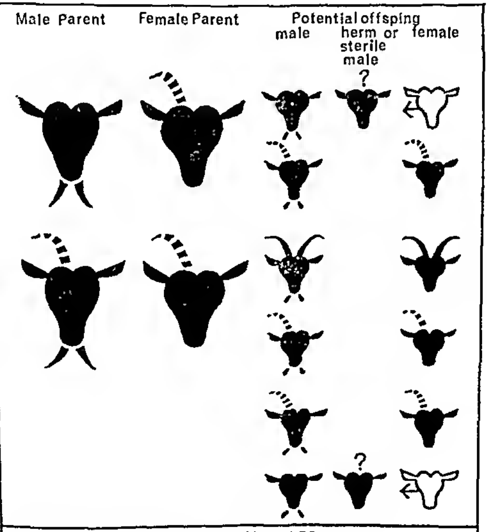


Fig. 24b. Hermaphroditism

other. The infertility of tbe pseudo-males shows itself in two distinct forms: either under-sized testicles, or a blockage in the seminal ducts in hoth testicles, causing the accumulation of sperm to form a small abscess. Few or no viable sperms are produced in either case.

The practical implications of this state of affairs are perfectly straightforward. There is no possibility of establishing a truly hornless breed of goats as no true-breeding hornless females are born. (To be exact, possihly one in a thousand hornless females is true-hreeding, but she goes unrecognized.)

But it is still worth while propogating the hornless factor, for



HORNLESS-NESS WITHOUT HERMAPHRODITES
Risky matings

24c.

convenience and for economy; and for the slightly greater fecundity where that is desired. None of the progeny of a horned/hornless mating will be sexually abnormal and half or more should be hornless. In a hornless/hornless mating, if the male is heterozygous, one in four of the female embryos will become hermaphrodites or pseudo-males; if the male is homozygous, half the female embryos will be affected.

The loss caused by hermaphroditism arises, not so much from the visibly abnormal kid, which is destroyed at birth, but from the pseudo-male or pseudo-female which is reared to maturity before its worthlessness is discovered. So it is seldom worth rearing the apparent female offspring of a homozygous male and a hornless female; the chances of normality are no more than evens. To exclude homozygous hornless males it is necessary in practice to exclude all hornless males, both of whose parents were hornless, until they have sired a horned kid from a horned female, and so proved their heterozygous state. Rearing the hornless offspring of the mating of a hornless female with a heterozygotic hornless male is still not a commercial proposition; reckoning the cost of rearing at about £17 and the selling price of the in-kid goat or buckling at about £20, the loss on rearing one hermaphrodite or pseudo-male eliminates the profit on six normal kids. You are offering six to one odds against a five to one risk; which is bad bookmaking.

Fig. 24 summarizes the situation in conventional symbols.

The most important dietetic causes of infertility in male goats are 'high calcium' phosphorus deficiency, vitamin-A deficiency, iodine deficiency and copper deficiency, to which falls to be added the somewhat mysterious effects of eating mangolds, which, when in season, are harmless to the female.

Vitamin-A deficiency and iodine deficiency impair the billy's keenness for service. Phosphorus and copper deficiency do not affect his willingness, but lower the quality of his semen. The cause and treatment of these deficiencies are dealt with in the chapter on Feeding. The danger of high-calcium phosphorus deficiency is, of course, enhanced if the billy is fed a dry diet and supplied with large quantities of hard (calcium-rich) drinking-water.

If the herd male is willing to serve and his semen when tested shows a normal content of active sperms, the cause of herd infertility must be sought among the females. In this search the goat farmer has less ground to cover than the cattleman. Goats are effectively free from

the highly infectious diseases that afflict tbe genital tract of cattle. Occasional infection of goats with contagious abortion occurs where the disease is prevalent among associated cattle; but goats have a high resistance to the disease and tbe worst that can be expected of it is an occasional abortion late in pregnancy.

Where the cause of a berd-breeding problem lies with the females, it almost always lies with tbe feeding. Vitamin-A deficiency is only likely to occur following herd infestatioos by liver fluke and coccidia, the symptoms of whieb (p. 256) are unlikely to pass unobserved. This deficiency does not affect the regularity of oestrus, but causes changes in the liniog of the uterus which make conception difficult and early abortion probable. Copper deficieocy is confined to notorious localities and is symptomized by irregular periods between 'beats', aod return to service at irregular intervals. Iodine deficiency is quite common (see Chapter 7, p. 148). As a breeding problem it shows itself in failure to come in beat, or irregular periods between heats; if conception is achieved the kids are usually carried full term, but most of the females and some of the males are born weak or dead; the vessels of first kidders show disappointingly little development. Where failure or irregularity in coming in heat is the problem, iodine deficiency is the most likely cause; if kale is being fed to a high-yielding herd with this problem iodine deficiency is even more likely to be the cause.

Pbosphorus deficiency is also common in high-yielding herds. As n breeding problem in a fair-sized herd it is not hard to spot, because while some of the goats will be on heat almost perpetually, and even start to develop male characteristics, otber members of the herd will refuse to come in heat at all, or at best but very seldom. It is less easy to spot nmong two or three goats, all of whom may show the same symptoms. The deficiency causes the development of a cystic ovary—tbat is, the folliele in the ovary turns into a cyst which persists in secreting either oestrogen (in whieh case the goat is perpetually in heat) or progesterone (in whieh case she eomes in heat but once or not at all). In either case service is ineffectual.

Unfortunately, a tendency to cystic ovaries can be an inherited factor; so the appearance of the typical symptoms in a closely related herd may be due to either phosphorus deficiency or inherent fault.

To distinguish between these two possible causes, note that the form of phosphorus deficiency that nfflicts high-yielding herds is due, not to a poverty of phosphorus in the diet, but to a superabundance of lime, which prevents the digestion of available phosphorus. The

typical diet which may produce it is one consisting of legume hay as the basic roughage, accompanied by a large percentage of sugar-beet pulp among the concentrates, and supplemented by an *ad lib.* supply of seaweed meal. If such diet is general to the whole herd, then it is liable to produce not only adult breeding problems but also a kind of chronic cramp in young stock, especially in very early spring. The picture of limping goatlings on the one hand and miscellaneous breeding problems on the other, is a conclusive pointer to phosphorus deficiency as the cause of both troubles.

While further incidence of phosphorus deficiency can be prevented by change of diet, it will take at least a month of changed diet to remove the symptoms of the deficiency, and a cystic ovary that is well established may be incurable. Veterinary surgeons can treat the condition with some slight hope of success and at very considerable expense, by injections of hormone. Perhaps the most economical and hopeful treatment is that suggested for the establishment of an artificial lactation, which should not be applied until the first flush of spring calls forth the natural aid of the thyroid gland to re-establish normal glandular rhythm.*

When breeding troubles are confined to an occasional individual in the herd, while the nutritional factors outlined above must still be borne in mind, the possibility of hereditary defect is very great in any goat that is not a proven breeder. Hermaphrodites range from the almost perfect male to the almost perfect female; though the intermediate types may be fairly easily recognizable the extremes of the range suffer from imperfections which can only be discovered at post-mortem examination. The proven breeder who fails to hold to service is more likely to be a victim of nutritional deficiencies if she is a heavy milker, or to be suffering from cystic ovary or over-fat condition if she is a poor producer.

HERD BREEDING PROBLEMS—FAULT-FINDING CHART

(1) Heat periods normal—goats return to service
Does the male serve?

IF HE DOES	IF HE DOES NOT
Have his semen tested.	Have a look at his feet. Give more greens, carrots, vitamin A.

* And only to goats which do not come on heat regularly.

Give iodized salt, seaweed meal.
Replace him.

IF THE SPERM COUNT IS LOW

Give soft drinking water, non-legume hay, no beet pulp or seaweed meal, but oats and bran and bigh phosphate supplement.

Give copper supplement.

Replace him.

IF THE SPERM COUNT IS NORMAL

Give greens, carrots, vitamin A.

Can he be infested with liver fluke? Or coccidia? If so, treat.

Replace him.

(2) *Heat too frequent or protracted and goats return to service*

Give soft drinking-water, non-legume hay, no beet pulps, no seaweed meal, but oats and bran and high phosphate supplement.

If there is no improvement after one month goats probably have hereditary cystic ovaries. Consult vet for expensive treatment.

(3) *Heat irregular, infrequent or absent; goats return to service*

Give housed goats range with a billy—or yard them together.

Give soft drinking-water, non-legume hay, etc.

Give iodized mineral supplement, including copper.

Suspect cystic ovary. Consult vet or try inducing artificial lactation in late April.

(4) Goats abort in late pregnancy

Suspect and avoid poisoning, especially with vermifuges, including garlic.

Rough management and narrow doorways.

Decrease feeding during early pregnancy and increase during last eight weeks.

Test for contagious abortion.

(5) Goats abort in early pregnancy

Are they infested with liver fluke?

Or with coccidia? If so, treat.

Or have they been so infested during previous summer? If so, give more greens, carrots, vitamin-A supplement.

(6) Difficult kiddings

(a) *The goat strains vigorously and the kids are strong.*

Decrease feeding in early pregnancy. Do not give cod liver oil.

(b) *The goat does not strain vigorously, kids are weak or dead.*

Increase feeding during last eight weeks of pregnancy.

Give iodized mineral supplement or seaweed meal.

(7) 'Cloud burst' or false pregnancy

Occasionally a goat, whether served or not, appears to be pregnant, but eventually 'gives birth' to a large quantity of water and nothing else. The cause is unknown. The goat breeds normally after the discharge has ceased.

KIDDING

Perhaps the greatest source of anxiety concerning the goat in kid is uncertainty of the day on which the kid will be born. The average period of gestation, from date of service to date of kidding, is 150 days. The normal range is from 143 to 157 days, which gives the herdsman who has noted service dates plenty of room for anxiety; if service dates have not been noted the goat will keep her attendant guessing for a month, and spring a surprise in the end. The only herdsman who is never taken by surprise is the one who passes his hand inquisitively over the goat's right side every morning and evening as a matter of routine.

In the pregnant goat, as she approaches her term, the kid can be seen and felt to move in the bulge on her right side. So long as that is the case, there is little likelihood of kidding within twelve hours.

The process of birth is started by the goat's ovaries secreting oestrogen; under the influence of this hormone, the muscular walls of the womb, which have remained flabby and relaxed throughout pregnancy, become hard and tense. The kid or kids which have kicked about in a flabby bag suddenly find themselves in a strait-jacket. If they do not lie still, their movements are so little felt by an outsider that they seem to do so. If the goats have been handled regularly there is no possible room for doubt about this change; if the goats have not been handled regularly the change will not be discovered by a panic-stricken last-minute exploration.

Any time from eight to twenty-four hours after the womb has tensed, in a normal birth, one of the kids is forced up into the neck of the womb. This movement causes the bulge in the right side to subside and tilts up the sloping plates of the rump to a more horizontal angle. The change in appearance can usually be noticed if one

is looking for it, but if the kids are many or big the subsidence in the right side is not very obvious. Once this stage bas been reacbed the first kid may be born within two or three bours.

Other signs of imminent kidding are a widening of the space between the pin-bones and a rapid filling of the udder. But in old goats and in goats carryiog a heavy cargo of kids the space betweeo tbe pin-bones may ring a false alarm weeks before kidding; in heavy milkers the udder is often quite tight and shiny ten days before kiddiog aod pre-milking may be necessary.

The secretion of oestrogen which tenses the walls of tbe womb also affects the bebaviour of the goat. A first kidder will often behave very much as if she were in season; an older goat is more likely to appear merely fussy and restless in the shed. But let the goats out of the shed togetber, and tbe goat whicb is about to kid is oo longer a member of tbe herd, oo longer follows her leader but maintains a purposeful aod divergent course quite foreign to her normal behaviour. The kidding goat in o free-raoge herd always gives fair warning if there is an eye to see it.

Like sbeep, goats seem able to postpooe or accelerate the birth of their kids to take advantage of good weather; older goats use their discretion in tbe matter more notably than first kidders.

The first good kidding day which comes withio the fortnight in which the kids are due is the normal choice of an experieoced mother. A good kidding day is a mild ond humid one witb o mioimum of wind; lambs ond kids are best born in n Scotch mist, where loss of heat by evaporation of the notal slime is at a minimum.

If the day is good and the terrain at all suitable, the best kidding pen is the secluded hollow that the goat will choose for herself, which is more hygienic than anything under a roof, and freer of hazards than anything with a flat floor and four walls. Most goats will choose a place under the cover of trees or rock; nn indiscreet first kidder may fail to do so and should be encouraged to think again; shelter from crows, showers and gulls is desirable. Otherwise human assistance is best limited to watching from n distance. Company of any kind, even of the dearest, is not desired, and it will be many hours before it is needed out of doors, even if things go wrong.

If, for sufficient reason, the goat must kid indoors, minimize the handicap. You cannot destroy infective bacteria as surely as the soil organisms do, but thorough scrubbing of walls and floor with soap and disinfectant, immediately before use, is a good second best. The goat will usually strain with her head against a wall or some solid

object. Make sure that there is ample clearance at the other end; drinking-buckets in a kidding-pen are likely to anticipate your decision as to whether the kids should be drowned. A goat about to kid is not thirsty; she needs all the heat at her disposal to keep herself warm when she loses the metabolic heat generated by her kids; the last thing she wants to do is to warm up a few gallons of water to blood-heat. But give her the most palatable roughage available, as she cannot choose her own; roughage makes heat. Cover the floor inches deep till it is as soft as the bed of leaf-mould she would have chosen for herself. Peat moss is best, sawdust second best, and straw or bracken a poor third, which trips up the kid and jags it in tender places. Then leave her alone; she may cry after you, but she is crying for the seclusion that Nature promised and you denied—not for your company.

Look in every half-hour or so and see how things are going. Note the time when you first see her straining. If a kid has not been born half an hour afterwards, something has gone wrong. The most likely cause of trouble is the flat floor. Kids have been presented to wild goats upside down, the wrong way round and all mixed up, by the million; and few of them have been the worse for it. For the wild goat soon finds that to stand with her forelegs a lot lower than her hind legs relieves the pain caused by the wrong presentation. If she holds the position for long enough, the wrong presentation often rights itself, because the kid tends to slide back out of the passage and into the womb. So have an artificial slope available. Some tightly packed bags of hay or straw, heaped in the corner of the pen, are better than nothing. The kidding crate (Fig. 25) enables an operator to deal with exceptional difficulties single-handed, without subjecting the goat to forceful handling by strangers. In many cases it can cure a kidding trouble without any manual interference at all.

In any case, if the goat has not kidded after half an hour of hard straining, put her on a slope with her fore-end down, and keep her there for about an hour; then let her stand level again for a further hour. If there is still no progress manual interference will be needed. Anyone who has had experience of parturition in animals of this size can approach the task with equanimity; the goat is more spacious than the sheep. No one lacking experience should approach the task at all without expert supervision. The veterinary surgeon is not always readily available at short notice, but a middle-aged shepherd of good repute is unlikely to refuse assistance and probably has more experience with animals of goat dimensions than the professional man; in

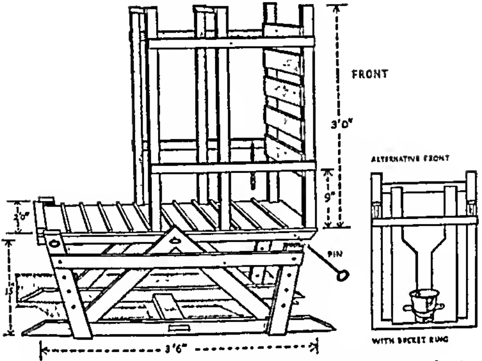


Fig. 25. The kidding crate, which is the goat's normal milking stand, set on a see-saw base

the very unlikely event of an inexperienced goat-owner finding himself without a veterinary surgeon or a shepherd to call upon, and with a case requiring manual interference, the following instructions may be of help in the emergency. The drawings in Fig. 26 illustrate the types of wrong presentation commonly found; they should be studied and memorized before the novice takes any practical measures.

There is plenty of time. For at least four hours after starting to strain the goat is better off without any inexperienced assistance. First ensure that the goat is firmly held, by the kidding crate* or your assistant. Then cut your nails short, scrub your hands and right arm up to the elbow in disinfectant water; dry on a freshly laundered towel; smear the arm and hands with acriflavine emulsion and proceed straight to the goat without touching anything with your right hand. Insert your hand into the goat's passage with the fingers bunched and extended. Close your ears and your eyes and think through your fingers alone. Feel and identify the shapes your fingers find. Though the membrane holding the 'waters' is usually presented first and broken in a delayed kidding, it may be found in the passage;

* The goat must be accustomed to being held in the kidding crate before she is due to kid. She may, otherwise, be terrified by it.

if so, break it, and carry on. If there isn't room in the passage to acquire the information you must have, wait until the goat relaxes from straining, and then push everything firmly and steadily out of the passage into the womb—if the goat is held on a slope, with her fore-end down, the slope will help you. With your hand in the womb, it is usually possible to sort out the legs and the heads and to re-arrange them for correct presentation. Do not start pulling anything until you are quite sure what's what; then wait until the goat strains and lead the legs of the kid into the passage; at the next strain bring the head through. If the goat is still straining strongly you can withdraw your arm at this stage and let her finish the job herself—stand her on the level to do so. Otherwise bring the kid through the passage by stages in sympathy with the goat's straining.

It sometimes happens that a fat goat or an old goat, after giving every indication of imminent kidding, does not start straining within twelve hours, or strains but weakly and seldom, and stands about looking miserable. Put her on a slope, fore-end up, for an hour, but watch her—with the help of gravity she may kid quickly and easily. After an hour set her level and prepare to investigate. If your arm can get into the passage the kid can come out; if not, the passage is either not fully open or has already started to close. Should there be any chance of the latter, the job is an urgent one for the veterinary surgeon and no one else.*

Whenever there has been handling of the womb and passage the goat should be given a vaginal douche and have a pessary inserted in the vagina.

Though kidding troubles should be rare, or easily dealt with by giving the goat a sloping surface to stand on, it is very common in high-yielding goats to find the udder becoming fully distended days or weeks before kidding. Have no hesitation in relieving the state, taking a little milk at first, and milk her right out after three days. When she does kid her milk will be quite suitable for the kid, as the release of the large quantities of protective vitamin A into the milk does not take place until the goat kids.

For the health and peace of mind of both goat and kid the kid should be allowed to suck its mother for at least four days; this procedure will relieve the congestion of the udder, minimize the risk of mastitis and make for easier milking in the subsequent lactation. It will take two kids all their time to absorb the milk of a good milker;

* The normal procedure in this and other really difficult cases is Caesarian section under local anaesthetic, a highly successful solution.

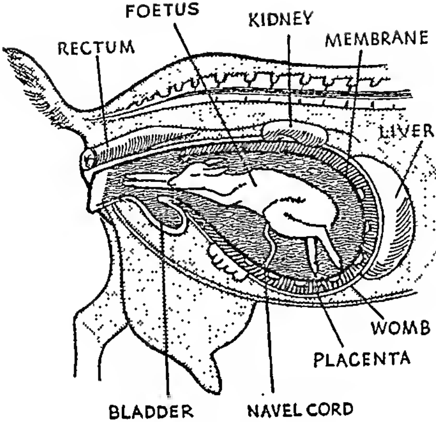
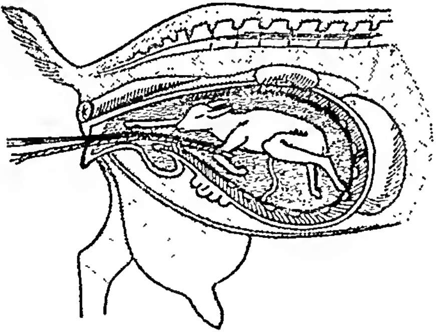
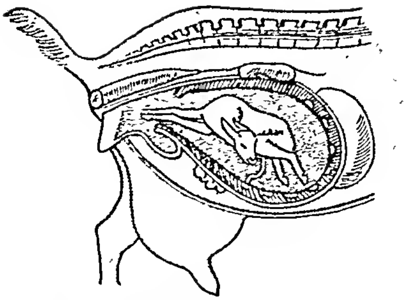


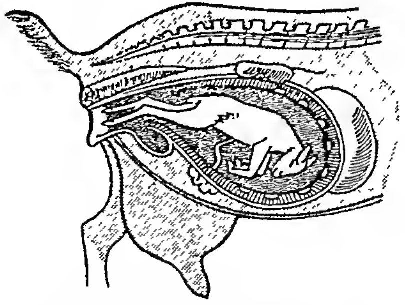
Fig. 26. Parturition diagrams. (1) Normal presentation



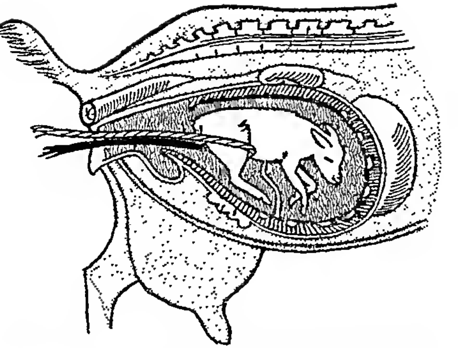
(2) Bring that leg forward—with your finger if possible



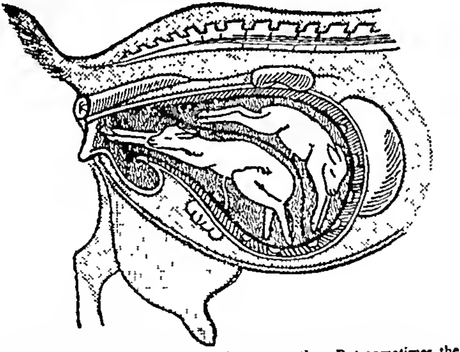
(3) Push the kid right back into the womb and bring the head forward on to the front legs



(4) It will come out the way it is; a normal presentation for the second of a pair of twins; but especially with an elderly goat ensure that it doesn't linger too long as the shoulders come through



(5) This one doesn't reach the passage at all, but sticks in the mouth of the womb; push him well back into the womb and deliver him in position (4). The rope shows what fingers should do



(6) All correct and normal for a twin presentation. But sometimes the hind legs of the second kid get in front of the head of the first. Then you find 4 legs and a head in the passage. Push it all back and bring out in the position shown

if she has been pre-milked they will leave plenty for the milking-pail.

Deformed, weakly and most male kids should be killed at birth; drowning is the best method. But not until they are two or three weeks old can female kids be selected with any degree of accuracy. The smallest kid at birth is often the largest and best at maturity; the first few weeks of life bring about very marked changes in the relative promise the kids show.

If she cannot be sucked by her kids, the newly kidded goat should be milked as soon after she has kidded as possible, but only enough milk taken from her to relax the tension of the udder; thereafter she should be milked twice daily, but not milked out fully until the third day after kidding.

The process of kidding is completed when the goat casts her cleansings: in a normal kidding this will happen about half an hour after the last kid is born; in difficult kiddings the cleansings may be hanging from the goat for twenty-four hours, or they may be retained in the womb.* In either case the assistance of the veterinary surgeon is required. Very seldom is any harm done by a goat being allowed to eat her cleansings, or that part of them which she chooses to eat; nor is there any reason to believe that the goat is any worse off if her cleansings are removed before she has had a chance of eating them—which from the attendant's point of view is usually the less nauseating alternative.

After kidding, some goats will take a drink of warm water, or a thin oatmeal gruel, or a bran mash—the offering of these 'luxuries' is common practice and a relief to the feelings of the attendant. But the goat's main need for the two or three hours after kidding is rest and peace. Having taken of these she is ready for her usual greenstuff, hay and water, but is better to have less rather than more of concentrated feeding for the following two or three days, unless her general standard of feeding is low.

Immediately after birth kids should be inspected for deformity. The commonest deformity is the supernumerary teat, that is one or more teats in excess of the normal ration of two. So long as the supernumerary teat is sufficiently separated from the normal teat as to be unlikely to interfere with milking, the abnormality is not serious. The surplus teat may be ligatured or removed with surgical scissors. But if two teats are close together—a double teat to all appearances—then the kid is better destroyed.

Another deformity which is visible at birth is the more obvious

* There is one placenta per kid; keep a count; *identical* twins have a double placenta.

form of hermaphroditism, in which the vulva of the kid is slightly enlarged and the tip of the vulva holds a small pea-shaped body. The kid should be destroyed and the mating that produced it not repeated.

Three or four days after birth the kids should be examined for horn-buds. These appear as tight curls of hair on the head; press on the curl and you can feel the point of the horn-bud under the skin, movable and not yet firmly attached to the skull. In case of doubt, cut away the hair over the suspected horn-bud and the point of the bud will usually be visible as a white spot under the skin.

The best method of disbudding kids is the use of the red-hot disbudding iron, obtainable from veterinary suppliers. Two operators are required; one to hold the kid firmly between his knees, the other to manipulate the iron. The iron should be heated to cherry-red heat and applied briefly (six seconds) but firmly to the horn-bud, searing down to the skull. This cuts off blood supply and nervous connection from the horn-bud. Then, with the rim of the disbudding iron, sear down the point of the bud. Reheat the iron and repeat the process with the other horn-bud. Bandage the kid, feed it and lay it down to sleep. There is little pain, but some irritation the following day when the scar starts to heal.

The human operator is often in agony, so it is as well that a 1963 Act made it obligatory to operate under anaesthetic. A local anaesthetic seems to cause as much pain as it suppresses, and does not keep the kid still. A general anaesthetic (nembutal in milk?) should be administered by a veterinary surgeon: its use may encourage the surgeon to make a thorough job of searing down the horn-bud, previously a rare achievement!

Dehorning adult goats in this country is unlawful unless the operation is performed by a veterinary surgeon. In countries no less enlightened (e.g. New Zealand) the operation is performed by applying an Elastrator rubber ring around the base of the horn approximately ⅛ in. below the junction of skin and horn. The horn falls off after eight to ten weeks or less if the goat is young; there is some local tenderness before the horn falls off, and some slight bleeding when it eventually detaches itself.

De-Odourizing Goats

A technique has been developed by the Robert Ford Laboratory, Pascagoula, Mississippi, U.S.A., to remove a goat's musk glands, making male goats inoffensive, and eliminating the 'goaty' flavour from the milk of the occasional goat so effected.

The male goat has a well-known habit of labelling his friends, females and furnishings with his personal stink, by rubbing his head on them. The musk glands are situated in a $\frac{3}{8}$ to $\frac{1}{2}$ in. wide band immediately behind, and along the inside edge of, the base of each horn. In a naturally hornless animal it is situated similarly around the bony boss. In a disbudded animal the gland is to be found where it would be if the animal were horned (see Fig. 27).

Musk glands are present in both sexes. Being activated by the presence of male hormone in the blood, their activity is seasonal in the male and unusual in the female. In an adult, when the normal cover of hair and dirt is removed, the glands are seen as an area of thickened and glistening skin; if active, the skin is raised and folded, forming three corrugations on each side; in a kid the gland is shiny, and darker than the neighbouring skin.

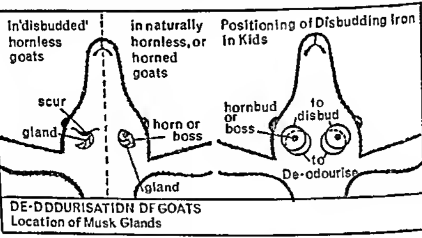


Fig. 27. De-odourization of goats

The de-odourization procedure is a simple extension of the disbudding technique, the glandular area being scorched to a bone-like appearance with a red-hot disbudding iron, in the same way as the horn-bud. An adult goat, if hornless, can be de-odourized by cauterizing the gland in like manner; if horned, the horns would have to be removed along with the glandular skin, by a long and bloody operation which would be hard to justify. In Britain all such operations must be carried out under local or general anaesthetic. But in commercial dairy herds and many domestic herds there would be much advantage for little extra expense if all available kids were 'de-

odourized' when horned kids were dishudded. The standard dishudding iron can he used, heing applied as shown in Fig. 27. The Rohert Ford lahoratories make a special iron for the joh.

There are no serious snags in the procedure. Male fertility is not affected and kids 'mother' normally. A few animals have small patches of musk gland on other parts of their hodies; these can he located hy nose, after shampooing the goat, and cauterized in the same way. Care is needed to avoid scorching through the hand of skin that runs hetween the horns, otherwise healing is delayed. A goat suspected of producing goaty milk hecause of an activated musk gland can he tested by ruhhing the glandular area with your hand for a few moments and sniffing.

Chapter 11

DISEASE AND ACCIDENT

Why should the writer of a hook on animal husbandry he expected to devote a section to disease? The rest of the hook is presumably intended to describe the ways and means of keeping the animal in a healthy and productive state. What more is there to say but to repeat what has already been said? If disease arises in spite of the combined efforts of reader and writer—as it will—then call in the witch doctor, the veterinary surgeon or herbalist, who are technically equipped to deal with the symptoms of disease without removing the conditions that caused it. Their technical equipment is specialized and to be respected; to crih a few of their more popular spells and prescriptions is neither serviceable nor respectful.

If such were the accepted view of the respective roles of stockman and veterinary surgeon, it would be sufficient to supply a few notes on first aid in case of accident, and leave the matter at that.

But such is not the generally accepted view. Far from it. The stockman is visualized as defending his charges from a malicious, ever-lurking legion of hacteria, virus and parasite intent on their destruction. The modern stockman is therefore armed with drugs, vaccine, sera and disinfectants to neutralize, suppress and destroy every possihle agent of disease. Modern man has made disease after his own image, and determined to kill it.

This is madness, with a monstrous vested interest hehind it, and not a scrap of science. The first fact the scientific student learns ahout hacteria is that they are neutral—they have no desire nor ahility to do anything whatsoever, but that which their environment commands. They multiply only if and when their environment is suitahle for their multiplication; they die when it ceases to he so. There is no fight, no argument. A virus is as malicious as a lump of salt. Some forms of virus even look like one—the tobacco virus, for instance, can he crystallized, labelled with its chemical formula, and kept in a glass hottle for as long as you like. Dissolve it, inject a droplet into

the right kind of tobacco plant in the rigbt place and it multiplies, producing the symptoms of disease.

The conditions under which any given strain of bacteria or virus can multiply rapidly are very highly specialized. In the case of disease bacteria these conditions only exist in one particular type of animal, or in a few allied species. If the symptoms of disease are very severe, or fatal, the conditions which favour the multiplication of the bacteria concerned must be highly abnormal in the animal species affected, or both the species and the disease bacteria would long ago bave perished. On the other hand, disease bacteria which produce only mild symptoms may be able to infect under relatively normal conditions.

In fact, any large animal is a focal centre for a vast and diverse population of micro-organisms and 'parasites' whose way of life is intimately bound up witb that of their host, and who depend on the survival of their host for their own existence. Some sections of this multitude of micro- and macro-'guests' are essential to the well-being of their host; others appear to be of little account, one way or the other: some can be helpful or dangerous according to circumstances; others are harmful to the individual they infect, but may act as a useful control of overcrowding when their host is running wild under natural conditions. It seems likely that disease bacteria exist in all these sections.

The relationship between the animal and its 'guests' is well regulated to ensure the survival of both. The more dangerous guests can only gain entry and multiply in the animal body under most unusual circumstances; the less dangerous but potentially harmful guests by their activity in the animal body either destroy their own means of sustenance or produce antibodies which control their own multiplication within limits which are safe for the host. The useful members of the community are encouraged to multiply by the circumstances in which they can be useful.

This regulating mechanism works well under normal conditions; if it is to work well for our goats we must feed, house and manage them to accord as nearly as possible with the life they would lead under favourable natural conditions. In so far as we are obliged to depart from the natural régime, we must expect some breakdown in the mechanism and be prepared to offer additional protection. But the mechanism is generally beneficial: to treat all potentially dangerous bacteria and parasites as enemies is both senseless and expensive.

In haodling problems of disease goat-keepers caooot afford to allow themselves to he hullied. The very large vested ioterests in the sale of veterinary products take great pains to ensure that the advice they advertise oo the treatment of the maio categories of farmstock will oot produce adverse results. Occasiooally their pains are io vain, hut, generally speakiog, to follow such advice is unnecessarily expeosive rather than disastrous. But the effect of these drugs aod injectioos upon goats cao oever be adequately tested, partly hecause there are too few goats available for full-scale field trials with statistical significance; partly hecause there are too few goat-keepers to make the research worth while.

Oo the other haod, crazy aod disgusting as the attitude to disease preached hy some of these companies may he, many of their products aod methods are the best availahle and perfectly satisfactory if sanely employed.

If we move goats from ao area io which pustular dermatitis or louping-ill are noo-existeot, ioto ao area where these diseases are prevaleot we are well advised to inject them with vaccine. Sueh movemeot over loog distaoces is unnatural to the goat. Goats reared in an infective area will have absorbed aotibodies to the disease in their mothers' milk; coostaot contact with the disease bacteria cooceroed maiotains their resistaoce. If we iotroduce goats from a non-infective area we must artificially provide them with aotihodies to the diseases, so that the oatural host-guest relationship may operate. Ooe artificiality demands another—a good rule io the treatment of disease and a good reason for natural feediog aod management.

Similarly, the deep wound from the mislaid hay-fork, which gives the deadly tetanus bacteria their rare opportunity of invading the goat, is not one which we should treat with garlic ointment, but with a chemical disinfectant, iodine or hydrogen peroxide. If the district is ootorious for tetanus infection, the goat should promptly receive an injection of antitetanus serum.

On the other hand, the hacteria which are associated with most forms of mastitis in goats can only operate when the goat and its udder are nlready in a diseased condition, due to had feeding, bruising, chilling or over-exploitation. The bacteria are helpful scavengers. It is often quite easy to suppress them with drugs; but the ill will out in nnother way. It is better to treat the cause. But black garget in a goat being sucked by n lamb will be due to the goat being exposed to bacteria to which it has no resistance; one artificiality demands another, hring out the antihiotics.

The general relationship between the goat and her micro-guests is not different in kind from that which exists between the goat and such visible guests as lice, ticks, tape-worm, round-worm, lung-worm and flukes. The goat and her parasites have been associated far too long, for the association to be normally dangerous to the goat. However, domestication has done more to disturb the goat's relationship with her parasites than her relationship with her bacterial visitors, so her parasites seem to be considerably more trouble than they are worth; indeed, there is no very obvious reason to suppose that they perform any useful function at all—except the general rule that Nature seldom lets any form of life go on leaving a negative balance behind it indefinitely.

The louse and scurf mite may do some useful scavenging on the unhealthy skin of goats in poor condition, or those who see too little of fresh air and rain—the scurf mite indeed specializes in the unwashed forelegs of an over-housed billy. The liver flukes and coccidia can hardly be expected to make any positive contribution to the goat's well-being, for they have no natural right of access to the goat, who naturally avoids the water-sodden and close-cropped pastures on which these parasites reach their infective stage. But the round-worm and lung-worm seem to feature eternally in the organs of goats both wild and domesticated, from the Tropics to the Arctic Circle: their presence in moderate numbers does no harm; it is impossible to say for certain what good it does.

But we may venture a reasonable guess. Fig. 28 is a worm-infestation graph superimposed on a graph showing the seasonal changes in the goat's metabolism. The picture of the early spring infestation falling off during summer, and the lesser and briefer autumn infestation of adult goats will be familiar to all goat-keepers, and is undoubtedly substantially correct. In fact, the graph is drawn from the worm egg counts of some hill ewes, whose breeding season occurs later in the year than the goat's, and has been shifted along the time base to coincide with the seasonal metabolism of the goat in the same way as it coincides with the seasonal metabolism of the hill ewe. It does not therefore *prove* anything, but it illustrates some interesting suggestions.

In the first place we note that worm infestation rises and falls in sympathy with seasonal metabolism—a remarkable state of affairs if the sole function of the parasitic worm were to lower the goat's condition. Then we note that the worm infestation rises sharply in early spring, when low temperatures, regular ground frost and the dry

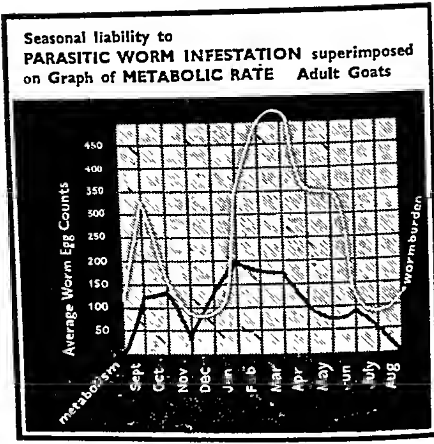


Fig. 28*

condition of the herbage are as hostile as they can be to the development of infective worm larvae—and again in early autumn when the free-range goat is beginning to turn her attention to the rougher and drier fodders and has no need to eat a morsel of food which grows less than a foot or more from the ground—a height to which few infective worm larvae will venture.

So we reach the more surprising situation. The goat not only consumes these 'damaging' worm larvae at a time when she is rising to the peak of her condition, but also at times when they are particularly hard to come by in the normal course of her grazing habits. Finally we note that the infestation occurs at times when the goat's diet is changing from the hard foods of winter to the soft foods of summer, and back again, from the soft foods of summer to the hard

* After White and Cushnie, *British Journal of Nutrition* 6, and Asdell and Turner, op. cit.

foods of winter, and when a parallel change is taking place in the utilization of the food nutrients, for the udder in summer, for body reserves in winter.

It seems more reasonable to suppose that the worm infestation plays a helpful role in carrying out these seasonal changes in metabolism and digestion, than that the whole unlikely arrangement is simply designed to keep a superfluous worm population in uneconomic circulation. The fact that the eradication of the common round-worms by phenothiazine dosing of sheep has been followed by fatal infestations of a hitherto disregarded parasite (*Nematodirus*) suggests that the wormless sheep and goat is not a whole one.

The wormless sheep or goat is, in fact, an ideal to be cherished by the salesman of veterinary medicines, and by no one else. The natural resistance of sheep and goats to heavy infestation, by the round-worms which are common to both, has been shown to depend, partly on their general physical condition, and partly on the maintenance of a permanent low-level infestation. A sudden sharp rise in the intake of infective worm larvae will cause a damaging infestation; a gradual rise, even to very high levels, merely increases resistance. The wormless goat is a 'push-over' for even a small intake of infective larvae.

Apart from the goat rendered wormless by dosing, the goat which is housed all winter and fed exclusively on hay, roots and concentrates, is liable to be wormless by spring. And kids, of course, are born wormless. These are the categories which require protection from heavy infestation, and all goats in poor condition.

Personally, I feel the herbalists have proved their case for garlic as a vermifuge; especially for the regular use of garlic as a deterrent. Garlic does not cause wormlessness; nor does the old-fashioned nicotine and copper-sulphate drench; phenothiazine can produce satisfactory results if dosing is not repeated too frequently; thiazol is less toxic, non-staining, and more effective. Such worm medicines may be given to the susceptible goats after three weeks on the pasture; to all the grazing companions of a heavily infested goat; and to all goats on close-cropped summer pastures after a fortnight of warm wet weather. For such preventive treatment the use of garlic is ideal; give a plant or tablet of garlic on alternate days for a week, immediately after the morning milking. Use phenothiazine or thiazol only to cure cases of severe infestation.

From this introduction it will have become clear that the specific advice which follows is based upon a compromise between 'nature cure' methods and orthodox veterinary practices. For the undiluted

'nature cure' doctrine, consult *Cure Your Own Cattle*, F. Newman Turner; fnr pure ortbodoxy, ring up tbe vet.

ABORTION: *See* 'breeding troubles' (p. 229).

ACETONAEMIA

Symptoms. Misery, irregular cudding, droppings covered in dark, sticky mucus, breath smells of pear-drnps.

Occurrence. Sbnrtly after kidding in boused gnats fed a concentrated ratinn or nne containing a bigh prnportion of ronts.

Prevention. Correct feeding.

Cure. Cobaltized salt (p. 151) for ten days; increase rnughages in diet; treat as cobalt (vitamin B_{12}) deficiency.

ANAEMIA

Symptoms. Gradual lowering of condition and yield, diminishing appetite, sensitivity to cold.

Occurrence. Confinement to wet grass pastures and otber circumstances favouring beavy infestation witb parasitic worms; diet lacking in fibre or deficient in cobalt.

Prevention. Routine garlic dosing for goats confined to grass pastures; correct feeding; cobalt dressing of land (*see* p. 115).

Cure. Treat for worm infestation; give cobaltized salt fnr ten days; add seaweed meal to concentrate ration; give more and better bay.

BLOWN (BLOAT, HOVEN)

Symptoms. Tightly inflated flanks, misery, collapse.

Occurrence. On lush clnvery pastures in spring and autumn; and after raiding the food bin.

Prevention. Feed hay before lush grazing; herhal pastures.

Cure. Half pint linseed oil, charcoal tablets; keep moving. If nn point of cnllapse, jab through the peak of the distended flank, midway between last rib and pnint of the hip, with a knife and hnld open the wnund, with a tube or straws.

BLINDNESS (Contagious Ophthalmia)

Symptoms. One or bnth eyes watery; the water becoming thick, sticky and encrusted, closing the eye; when the eye reopens it is clouded and blind.

Occurrence. In several members of a flock in successinn; less

unusual after a hot dry summer, when goats have contact with sheep, when bog asphodel is present on grazing or there is frequent access to rape.

Prevention.

Cure. Self-healing in about two weeks; prevent goat from damaging herself and ensure she has adequate feeding; sulphacetamide eye lotion may speed recovery.

COCCIDIOSIS: *See* INTERNAL PARASITES.

COLIC

Symptoms. Spasmodic pain in the digestive tract; goat half-rises, sighs and goes down again; suddenly stops eating and looks anxiously about; increasing distress and death.

Occurrence. Commonest in young stock, conditions favouring worm infestation, excessive feeding of concentrates, especially dusty meals, access to cold water immediately after concentrate feed, in kids after swallowing bottle teat, after poisoning.

Prevention. Correct feeding and constant access to water; feed the flock roughages together; hold the teat when bottle-feeding.

Cure. Half pint linseed oil (for adults, less for kids), followed by a glass of spirits in two glasses of water, repeated hourly till pain subsides.

COUGHS: *See* INTERNAL PARASITES (Lung-worms).

CYSTIC OVARY: *See* 'breeding troubles' (p. 229).

CUTS AND WOUNDS

Clean cuts if not very wide should be dabbed with terebene balsam to ward off flies, and left to heal themselves.

Wide clean cuts should have the hair about them clipped, be washed out with boiled brine, and covered with acriflavine gauze and adhesive or 'Prestoband' bandage.

Dirty, ragged and bruised cuts should be washed out with boiled brine, not stitched, and covered with acriflavine gauze or lanette. If you can afford to be as generous with 'Dettol' or other proprietary disinfectant as you can with brine, use it; if not, don't. But use only in recommended dilution.

Deep penetrating cuts and pricks should be cleaned out to the

bottom witb hydrogen peroxide, nr injected with iodine solution; tbe deeper and narrower the mnre dangerous they are. In tetanus districts inject antitetanus serum.

Cuts on tbe udder wbicb penetrate to the teat canal and cause milk leakage sbould be wasbed nut with brine, dusted with sulphonamide powder, stitched and covered. If milk leak persists after forty-eight bours, implant stilboestrnl (*see* p. 220) but not in a pregnant goat.

DIABETES is known to occur in goats, and tbe not infrequent cases of slight acetonaemia, or bitter-flavoured milk in newly kidded goats may be due to mild diabetes. It is not curable, but mild symptoms can be expected to disappear after a week or twn, as the stress subsides. Their going may be bastened by feeding a fibrous diet, supplemented with one or otber of tbe various proprietary mixtures of urea, mollasses and minerals (e.g. 'Rumevite'), used to stimulate rumen activity.

DIARRHOEA (Scour) is not a disease, but a means of getting rid of toxins and a symptom of worm infestatinn, poisoning, indigestion, entero-toxaemia. In kids it is most frequently due to the prnvision nf cold milk or tbe use nf unsterilized feeding-bottles. In that case feed water with a little glucose added in lieu of milk for twenty-four bours.

ECZEMA: Several forms of skin disease occur in goats, two nf which have tbe appearance nf eczema:

Contagious Pustular Dermatitis

Symptoms. Pimples abont the nose and mouth, less often about the eyes, anus and boofs, turning to watery blisters and then to sticky and encrusted scabs. Loss of condition and appetite.

Occurrence. A local infection in sheep country, commoner in Eastern districts. Ynung animals are most frequently attacked, but all ages liable nn first contact with infection.

Prevention. Home-bred stock in an infected district have natural immunity. Vaccine will give protectinn tn others.

Cure. Wash twice daily with brine and dress with gentian violet nr iodine.

Goat Pox (Cow Pox)

Symptoms. Pimples turning to watery blisters, then to sticky and encrusted scabs on the udder. If scabs are removed before 'ripe' weeping sores remain.

Occurrence. In very widely varying degrees of severity it occurs commonly; in a very mild and evanescent form in well-managed flocks; severely in others; the first attack gives high immunity.

Prevention. Very mild forms are of no account; correct feeding and management will control severity; scrupulous dairy hygiene and isolation of infected milkers, which should be milked last and the hands disinfected thereafter, will control the spread of severe outbreaks.

Cure. Time and gentle milking. Internal garlic treatment, or the administration of Epsom salts will speed recovery. Dusting with boracic or Fissan Ichthamol powder controls discomfort.

ENTERO-TOXAEMIA

This is the worst goat-killer.

Symptoms vary somewhat according to the strain of bacteria concerned, but are usually consistent in any one flock. Staggering gait and loss of motor control is one of the less common symptoms; sometimes the goat is blown; extreme misery there always is, and almost always, a peculiarly evil-smelling diarrhoea. Coma and death within twenty-four hours are the normal sequel.

Occurrence. Ineradicable bacteria, indigenous to goats, and to all other domesticated grazing stock and their pastures, produce the poisons responsible, when conditions in the digestive tract deprive them of oxygen. In goats, a big feed of lush wet grass, or of concentrates and water, or a real belly-stretcher of milk, all produce the airless pudding in which the bacteria start poison production. Goats quickly build up resistance to the poisons produced in small regular quantities; it is the sudden change of weather and diet in spring and autumn, and the accidental gorges of goats in mischief that cause most trouble.

Prevention. Correct feeding on a bulky fibrous diet. The recommended sheep dose of entero-toxaemia vaccine for in-kid goats, during the first eight weeks of pregnancy; the lamb dose for kids at two to three weeks of age, and again at six weeks; and an annual

booster does in the spring for eild (or yeld) stock; this programme gives complete protection.

Cure. On first acquaintance entero-toxaemia is usually fatal before diagnosed. Once the characteristic symptoms have been seen they are more easily recognized when they recur. Immediate resource to the hypodermic syringe will usually save the goat. If there is contact with sheep, 20–80 c.c. of pulpy kidney serum, depending on size of goat, is helpful; otherwise two injections, each of 10,000 units of penicillin, four hours apart, or a single injection of 300,000 units of slow-release veterinary penicillin, is more likely to be successful; sulphamezazine (dose according to weight) gives good results; if an attack occurs after the use of pulpy kidney serum for prevention, penicillin or sulphamezazine should be used for cure; similarly if a goat has been saved previously with the serum, she is more likely to respond to other treatment for a second attack. Whatever treatment is to be used it must be kept in permanent readiness for immediate use.

Ergot Poisoning

Symptoms. Lowered condition, cold and loss of sensation in the extremities.

Occurrence. Among goats confined to pastures on which ergot, a fungus growth on flowering grasses and cereals, is prevalent.

Prevention. Remove the cause.

Cure. None.

Fluke: *See* Internal Parasites.

Foot and Mouth Disease

Symptoms. Sudden lameness and dribbling small blisters on the tongue, inside of lips and on the palate, also where hair joins hoof and between the claws of the hoof. Can be confused with contagious pustular dermatitis.

Occurrence. Rare.

Inform the police. Don't seek advice.

Foot-rot

Symptoms. Slight and increasing lameness in one or more feet, hoof uneven with stinking matter oozing between the outer horn and inner soft structures.

Occurrence. Among goats on sodden pastures or floors; but the

disease is either a regular visitor or an infected sheep or goat introduces it. The hacteria concerned can remain latent for long periods in the hoof, hut cannot survive a week on the ground.

Prevention. Dry floors and the avoidance of sodden pastures; regular exercise on hard ground.

Cure. Pare the foot level, remove loose horn and, very gently, as much dead matter as possihle. Soak all four feet for thirty seconds in a 'Dettol' solution (four tahlespoons to the pint of water). Repeat daily till sound. Then once every ten days for a month dip the feet hriefly in a copper sulphate solution, or proprietary foot-rot wash. Keep the infected feet, if not the goat, out of contact witb the communal pasture, using dolls' Wellington hoots, perhaps.

FRACTURES. A simple fracture (the limh looks longer than normal) is usually curable. A compound fracture is usually not. Dislocation of the shoulder is treatable under anaesthetic.

If the swelling prevents your locating the bones, send for the veterinary surgeon. If you can feel the position of the bones in a fracture, act immediately. Re-set the hroken hone, bind the join lightly with cotton wool or soft rag, splint it with two strips of light wood, aluminium or stiff cardboard and bandage with Presto-hand. Keep the bandage on for two or three montbs, or remove it after a fortnight and replace with a lighter support—this may he necessary if there is chafing of the skin under the original splint, in which case stiff paper over cotton wool, or close-textured cloth soaked in glue and allowed to harden while the goat is restrained, can replace the splints.

GAS GANGRENE occasionally infects a deep penetrating wound, producing a foul-smelling, bubbly discbarge. Deatb may follow in a few days. If called in at an early stage a veterinary surgeon can use surgical metbods, sulpba drugs and serum to control it.

HOVEN: *See* BLOWN.

HUSK: *See* INTERNAL PARASITES (Lung-worm).

INTERNAL PARASITES OF GOATS, RAPID REFERENCE CHART NOTES (pp. 256–7)

'*Other Hosts*'. Cattle are affected by at least one species of round worm infesting goats—*Haemonchus contortus*—which causes black scours on heavily stocked pastures. But they are immune to most of the others. They can be used for cleaning up infested grazings where 'alternate stocking' is advocated as a preventive measure. Horses are useful in the same role.

Symptoms. It happens more often than not that a goat heavily infested with one type of parasite is infested with several types, so symptoms may be mixed. Identification of the dominant parasite concerned is seldom possible unless symptoms are considered in conjunction with 'Conditions of occurrence'. The examination of dung in a veterinary laboratory may help, on occasion, to diagnose the parasite; but in well-fed goats serious infestation with few worm eggs in the dung is a common concurrence.

Diet Supplements. This column reflects current knowledge or knowledgeable guesses concerning the substances of which the various parasites rob their hosts. These are chiefly minerals and vitamins. Seaweed meal is advocated as a mineral supplement because the most innocuous and palatable available. For vitamin B, wheatgerm meal, Bemax, Phillips's poultry yeast, and Marmite, are good sources. For vitamin A and D either the dry vitamin supplement sold by leading agricultural chemists or the concentrated synthetic preparations, designed for infant feeding are recommended—e.g. Adexolin. Neither codliver oil nor natural sources of vitamin A are suitable, as the former is indigestible and the latter require the efficient functioning of a damaged liver.

Preventive Measures. Goats, like other ruminants, are in constant contact with the infective larvae of internal parasites which exist on the herbage, and habitually carry a small worm burden, which is harmless and part of the goat's way of life. Serious infestations arise from bad management—either in confining the goats to overstocked and unsuitable pastures or breaking down their natural resistance by bad feeding, bad housing and over-exploitation. Preventive measures suggested here are designed to minimize the consequences of bad management. 'Routine Garlic' means giving each goat a garlic tablet or a wild garlic plant on alternate days, or every day, immediately after milking in the case of milkers. This measure enables goats to tolerate exceedingly bad pasture management with impunity.

Johne's Disease

Symptoms. Loss of condition, occasional scouring becoming more frequent with bubbles of gas in the droppings; appetite variable, greed and indifference alternating; emaciation, weakness, death. May take several months to run its course.

Occurrence. Occasional among adult goats fed an over-concentrated ration, especially when in contact with cows so fed. Highly contagious.

Prevention. Correct feeding and management.

Cure. The only cure claimed is a somewhat elaborate herbal cure described in *Cure Your Own Cattle*, by Newman Turner. It is inadvisable to attempt this cure if other stock on the holding are fed large quantities of concentrates and have been treated with suppressive drugs and sera. The danger of infection is too great.

Lactation Tetany

Symptoms. Anxiety, uncontrolled movements, staggering, collapse, convulsions, and death—in rapid succession.

Occurrence. In goats reared and maintained on a concentrated phosphate-rich diet, most commonly when put out on to pastures in the flush of spring; often also in autumn towards the height of

the breeding season. The similar disease of Milk Fever occurs only during the forty-eight hours that follow kidding.

Prevention. Correct feeding and management with particular reference to mineral balance; magnesian lime dressing of land, 'herbal' pasture and meadows.

Cure. Immediately inject 3 oz. standard magnesium sulphate solution subcutaneously; if a veterinary surgeon is immediately available let him inject intravenously.

LICE

Symptoms. Hairless tips to the ears, dull coat, exceptional fidgetiness.

Occurrence. In goats in poor condition, especially those which have little access to the open air, and to rainfall.

Prevention. Remove the conditions of occurrence.

Cure. Wash with 4 oz. derris powder and ½ oz. soap powder in 2 gallons warm water; dry without rinsing and don't brush out the powder. DDT is less effective for killing the nits and more dangerous if used in powder form. Gammexane dusts are highly unpleasant to use owing to the suffocating smell; against nits they are no more effective.

LOUPING ILL

Symptoms. Dullness and fever, followed by tremor, muscular spasm and bewildered gait, often by collapse, paralysis and death.

Occurrence. On tick-infested pastures in Scotland, north of England and north Wales during the period of tick activity—April and August-September. Home-bred young stock are but slightly affected, seldom developing the nervous symptoms; home-bred adults are very seldom affected at all; newcomers of all ages are liable to serious infection during the first tick season.

Prevention. Home-bred stock develop natural immunity. In-bought stock from a tick-free area should be inoculated with 5 c.c. Louping Ill vaccine in July and March of their first year.

Cure. Shelter, quiet and careful nursing will often save the patient. The presence of a congenial companion in the sick bay is a help.

MASTITIS. The goat is liable to all the forms of mastitis that affect the cow and also to black garget of sheep. Several different diseases with different causes are grouped under this head. Only the

INTERNAL PARASITES OF GOATS RAPID REFERENCE CHART

Type of parasite	*Round worms of digestive tract*	*Lung Thread worms*	*Lung Hair worms*	*Tape worms*	*Liver Flukes*	*Coccidia*
Other Hosts	Sheep and deer	Sheep and deer	Sheep and deer	Sheep	Sheep, cattle, deer, rabbit	Rabbits, poultry, wild birds
Conditions of occurrence	All year round. All ages. Severa only when grazing short grass or arable forage creps.	Severe in kids, mild in adults. Wet pastures and weather. Autumn.	All year. Adults. Wet grass.	March to October. Mainly in kids.	August to January. All ages. Presence on pastures of ¼" long mud snail with pointed shell, living in semi-permanent mud. Wet summers.	May to October. All ages, worst in kids. On short grass shared with poultry or rabbits.
Symptoms	Scour, Soft lump under jaw. / Anaemia, wasting, no scour.	Harsh cough and sticky discharge from nose. Wasting.	Dry cough. No discharge. Poor condition.	Usually mild. Wasting, Rickets, tetany, occasionally.	*Acute form* Dullness, distended abdomen, painful on pressure at junction of ribs and breastbone. Death in a few days. *Chronic* Dullness, anaemia, wasting, pale gums, soft swellings under jaw and abdomen. Only slight scour.	Continuous or recurrent scouring, often profuse and blood-stained. Abject misery, no appetite. Death may occur after 5 days' illness. Relapse 2 weeks after apparent recovery.

Treatment	P.T.Z. Copper sulphate and nicotine.	No specific. P.T.Z. or garlic	No specific. P.T.Z. or garlic	Copper sulphate and nicotine.	Hexachlorethane.	Sulphamezathine.
Supplement Diet with	Seaweed meal and 'B' Vitamins.	Garlic and seaweed meal.		Seaweed meal, and lime rich foods. Vit. 'D'.	Vitamin 'A'.	Vitamin 'A'.
Prevention.	Rotational Grazing—1 week on, 3 to 4 weeks off. Alternate stocking. Routine garlic.	Prevent access to pasture in dull wet weather. Alternate stocking.	Dress land in summer with 20 lb. ground copper sulphate mixed with 80 lb. sand per acre. Alternate stocking.	Bottle feed kids. Alternate stocking. Routine garlic.	Drain and dress wet patches as for Lung hair worm. Dose all liable stock with 'hexachlorethane' in October.	Exterminate rabbits. Add nitrofurazone to poultry food.

NOTES

Doses. All worm medicines are poisons, and until experience in their use is acquired, veterinary advice is desirable. The following doses are an approximate guide for use with full-grown goats:

P.T.Z.: 30 to 40 grams according to size. White goats and goats fed concentrates in excess of 1 lb. per day may be sensitive to the drug, which should in such cases be given in equal doses spread over 3 days—i.e. 10–13 grams per day. For kids 3–6 months old, dose is 10 to 15 grams, 6 months to 1 year, 15 to 20 grams. Goatlings 20 to 30 grams.

Copper Sulphate–Nicotine: For proprietary mixtures use the appropriate sheep dose advocated by the maker. A 2 per cent solution of copper sulphate is made by dissolving 1 oz. 'bluestone' in 2½ pints water, add to this 1 fluid ounce 40 per cent nicotine sulphate solution. Do all mixing in glass or enamel vessels.

TABLE OF DOSES

	Age of Goat				*Method*
	3 mths.	*6 mths.*	*1 year*	*Adult*	
P.T.Z.	*grams* 10	*grams* 15	*grams* 20	*grams* 30 to 40	For white goats, and goats fed more than 1 lb. of concentrates per day, divide dose into 3 parts and give 1 part daily for 3 days. Don't dose goats in-kid within 14 days of kidding nor males during rutting season.
2% Copper sulphate with nicotine (1 oz. bluestone in 2½ pints water with 1 fl. oz. 40% Nicotine sulphate solution added. All mixing in glass or enamel)	*fl. oz.* ½	*fl. oz.* 1	*fl. oz.* 1½	*fl. oz.* 2	Starve 12 hours before dosing, and 3 hours after, if goat is in good condition. May be used instead of P.T.Z. for in-kidders and males when necessary.
Hexachlorethane	*grams* 10	*grams* 15	*grams* 20	*grams* 30–40	Give required weight of powder mixed and well shaken with water as a drench.
Sulphamezathine	— is available only under veterinary prescription.				
Thibenzole	*tablets* ¼	½	*tablets* 1	1 to 1½	Safest Method. Adult dose according to weight.

minority of cases of mastitis in goats are associated with specific bacteria; many cases are not associated with bacteria at all; some forms are highly contagious to all goats; others are contagious

only to goats in ao unhealthy condition; others again are not infectious at all.

Aeote Mastitis

Symptoms. Misery, udder hot, hard, and very teoder, the milk elotty aod often blood-streaked, the appetite is lost aod the pupils of the eyes are oarrowed to slits. Io the worst cases the udder may putrefy and slough away aod the goat die io high fever.

Occurrence. Io goats fed a conceotratioo diet especially duriog the first fortoight after kiddiog, aod followiog iojuries to the udder. Highly contagious to goats similarly fed.

Prevention. Correct feeding and management; let kids suck for first four days of laetatioo.

Cure. Eight sulphooamide tablets (ooe dose only). Alternate hot and cold fomeotatioo of the udder, massage aod frequent stripping. Four garlic tablets daily for ten days, no food for forty-eight hours, access to warm water. After first forty-eight hours, give hay and tree leaves, but no other solids except garlic. After ten days continue with one tablet garlie a day, dry feediog and warm water until milk clears; theo work back to correct diet for yield.

Sub-Acute Mastitis

Symptoms. As for aeute mastitis, but appetite near normal, and less distress.

Occurrence. As for acute mastitis, but at any time during lactation.

Prevention. As for acute mastitis.

Cure. As for acute mastitis, omitting the sulphooamide.

Chronic Mastitis

Symptoms. Lumpy udder, occasiooal clots in the milk, occasional off-flavours, no notable discomfort, no distress.

Occurrence. As for sub-acute mastitis.

Prevention. As for sub-acute mastitis.

Cure. As for sub-aeute mastitis.

Summer Mastitis

Symptoms. Dejected or anxious expression, slitty eyes, lumpy

udder, which may develop into acute inflamed udder which putrefies or shrinks and hardens into a dead lump. Often fatal.

Occurrence. Mainly in goatlings or older kids during summer, occasionally in dry goats; only affecting flocks in which large quantities of concentrates or concentrated succulents are fed to young stock.

Prevention. Correct feeding and management.

Cure. As for sub-acute mastitis.

Black Garget

Symptoms. As for acute mastitis, but udder rapidly becomes black and gangrenous, either sloughing away or hardening into a dead lump. Often fatal.

Occurrence. Occasional in all goats after a wound on the udder, particularly a penetrating wound; in goats suckling a lamb.

Prevention. Remove barbed wire from fences; control dogs; bottle-feed orphan lambs.

Cure. A job for the veterinary surgeon, who may be able to get the anti-serum in time, and otherwise may succeed with antibiotics, or iodized oil suffusion. While awaiting the veterinary surgeon's arrival, carry out hot and cold fomentation, massage and frequent stripping.

Metritis

Symptoms. Slowly developing feverishness, to the point of acute misery and collapse, usually with an increasingly evil-smelling discharge from the vulva.

Occurrence. Occasionally before or immediately after kidding, especially when parturition has had to be assisted or cleansings have been retained twenty-four hours or more after kidding. Commoner in overfed goats, and in goats whose diet is slightly deficient in iodine—a purely seasonal deficiency of iodine often occurs in free-range goats in the heavy rainfall areas of the west at the end of the winter, giving rise to metritis before or after kidding.

Prevention. Strict attention to hygiene at difficult kiddings; correct feeding and management, with attention to iodine adequacy.

Cure. Streptomycin injection, obtainable from a veterinary surgeon.

Milk Fever

Symptoms. As for Lactation Tetany, but convulsions are less often apparent.

Occurrence. In goats reared and fed on a minerally imbalanced diet and within forty-eight hours of kidding; can occur in badly reared goats when being correctly fed.

Prevention. Correct rearing, feeding and management.

Cure. Inject 10 oz. standard calcium borogluconate solution at blood heat immediately; if goat is able to swallow give ½ pint raw linseed to guard against the blown condition which often follows. If the veterinary surgeon is sufficiently wise and old-fashioned he may inflate the udder. Reduce level of feeding and cut out concentrates for ten days.

PINK MILK. A trace of blood in the milk is common shortly after kidding, especially in first kidders, and is due to the bursting of small blood-vessels in the udder. If it is not accompanied by other symptoms, this is innocent. If the condition persists it indicates lack of calcium (or excess of phosphates—i.e. concentrates) in the diet.

POISONS. A goat is unlikely to eat poisonous plants unless they are fed to her in her feeding-rack. If the flock grazes together the risk is further lessened. But an occasional error in respect of the following may occur:

	Antidote:
Acorns (unripe)	½ pint linseed oil, laxative foods.
Hemlock roots in winter	Strong coffee, spirits, movement.
Laburnum	Strong coffee, spirits, movement.
Mangold and beet leaves	Ground chalk in milk suspension.
Rhododendron	Linseed oil, white of egg, milk.
Yew	1 pint linseed oil, half bottle of whisky, keep moving (seldom successful).

PREGNANCY TOXAEMIA

Symptoms. Dullness, stupidity, loss of appetite, collapse and death, within the course of twelve to forty-eight hours.

Occurrence. Occasionally in goats on all standards of nutrition, whose diet fails to improve in quality during the last six weeks of pregnancy; lack of exercise increases liability.

Prevention. Correct feeding and management with special reference to steaming-up and regular exercise.

Cure. Unlikely. Enforced exercise and nourishing gruels (tree barks and honey), followed by a sappier and richer diet may save a goat on a low standard of nutrition.

PNEUMONIA

Symptoms. Goat looks cold and miserable, sighs, groans with each breath, back arched, tips of ears and sometimes other extremities cold, pressure on the side causes pain; with the ear pressed to the flank it is sometimes possible to hear a rustling in time with the breathing, or, in later stages dripping and the movement of water; the goat lies down, soon becoming too weak to rise.

Occurrence. There are a number of forms and causes of pneumonia and pleurisy and occurrence is very general; the goat has little external protection from the cold and her internal protection depends on the contents of her rumen; any form of chill, however slight, which strikes while her internal protection is low may induce pneumonia. Goats fed concentrates before a journey will usually arrive at their destination with pneumonia.

Cure. Give six sulphonamide tablets, and after four hours four more tablets. Rug the goat, make a deep bed of fine hay, burying under the top layer as many hot-water bottles as can be obtained, cover the top of the bed with sacking or rugs and confine the goat as far as possible to this bed; bring into the shed in which the goat is as many portable heaters as possible and make every effort to maintain as hot and humid an atmosphere as can be managed, but not a variable one; smear the chest with a cream of mustard and vinegar, to which a little turpentine may be added for a thick-coated goat; drench with proprietary chill drench, or with a 'toddy' of a glass of whisky in warm water and honey; repeat every hour. Nursing is the key to a cure of pneumonia. The veterinary surgeon may give much help and should be consulted at an early stage; long convalescence is inevitable, and no high production nor exertion should be expected of the goat for three months. In convalescence a laxative diet will be needed.

PULPY KIDNEY DISEASE. A form of entero-toxaemia affecting kids when they first go out to pasture on good grass and fodder crops. The symptoms are those of entero-toxaemia. The cause is the feeding of an over-concentrated diet. Nothing can be better for the kids than to accompany the flock on rough browsing. But early summer grass has far too low a fibre content for the immature

digestion of the kid. If kids must go out to grass, feed them hay before they go; it spells less immediate trouble for the attendant to inoculate the kids with pulpy kidney vaccine a fortnight before putting them out.

RICKETS

Symptoms. Swelling of the leg joints and deformation of the legs in kids, swollen joints and changes in the formation of the rump and pelvic bones in adults (the disease is called osteomalacia in adults). Tremor and more serious nervous symptoms may also occur with or without the more obvious changes.

Occurrence. In kids and older goats fed a minerally deficient or minerally imbalanced diet, especially in housed stock during winter.

Prevention. Correct feeding and management.

Cure. Vitamin-D supplement and minerally balanced diet.

ROUND WORMS: *See* INTERNAL PARASITES.

SCURF OR SCAB (Mange).

Symptoms. Flaking 'dandruff' on the skin, accompanied by irritation, followed by hairlessness and the formation of thick, hard, corrugated skin over the affected areas.

Occurrence. Very common in goats in poor and unhealthy condition, prevalent in its most severe and unsightly forms in elderly males; more common in goats with little access to fresh air and rainfall.

Prevention. Correct feeding and management will limit infection to mild levels.

Cure. This disease is caused by a mite very closely related to the mite responsible for scab in sheep—which is a notifiable disease. It is cured by the same treatment. On a sheep farm goats may be run through the sheep dipper during the summer or autumn dippings. For individual treatment mix 4 oz. derris powder with ½ oz. soap powder and 2 gallons warm water; wash the goat all over with the mixture; dry without rinsing; in severe cases repeat within three weeks. Any standard 'approved' sheep dip at correct dilution may be used instead of the derris mixture.

TETANUS

Symptoms. Tense, anxious posture, head held up, neck out-

stretched, tail cocked to one side, difficulty in swallowing solids, muscular spasms, death within nine days.

Occurrence. Following a deep prick or penetrating wound, especially on fertile, well-manured land.

Prevention. Inject such wounds with iodine when they occur, and if tetanus is common on the farm use anti-serum.

Cure. A difficult job for a veterinary surgeon who will probably open the wound and disinfect it with iodine or other drug, and prevent further release of tetanus toxin. It is then up to the goat-keeper to nurse the goat through the effects of the poison already released. Keep the patient in as quiet a place as possible and preferably in the dark; feed gruels that can be sucked up, with tree-bark gruel as staple if possible. Success or failure will be registered by the ninth day.

TICKS—Attack all warm-blooded creatures on infested pastures; goats are most troubled by the 'seed' ticks which cluster around the lips, nose and eyelids, also on the udder. Treat with an anti-tick salve as sold for the protection of lambs—but not with one containing DDT. The type produced to the prescription of Professor MacLagan of the West of Scotland Agricultural College has a non-poisonous repellent as its active principle and can be smeared on nose and mouth with impunity; do not let any get in the eyes, but smear round about. This is also valuable for the attendant who becomes tick-infested.

LAMENESS. Apart from foot-rot and external injuries lameness may be due to rheumatism, arising from damp floors, draughty houses and the accumulated toxins of old age, to a form of phosphorus deficiency, and to an inflammatory disease, laminitis.

LAMINITIS

Symptoms. Sudden acute tenderness in one or more feet, which become hot and swollen; the acute stage may pass off in a few days or persist with the loss of the hoof; the goat goes down in condition in either case.

Occurrence. As a sequel to kidding in overfed goats and to digestive troubles in all goats; occasionally a sequel to bruising the feet on concrete floors.

Prevention. Correct feeding and management and the provision of well-insulated floors.

Cure. As for rheumatism, but no delay permissible. Also while the feet remain tender, apply cold, wet bran poultices to the feet, to keep the horn soft and pliable.

LUMPY JAW (Actino-mycosis)

Symptoms. Much swelling of the lips and of the flesh around the mouth, slobbering, multiple sores, later forming persistent raw, wart-like protuberances; little loss of appetite, but some difficulty in eating.

Occurrence. Occasional in goats grazing spiny fodder, especially on iodine-deficient land—e.g. gorse on river shingle.

Prevention. Remove the cause; give iodine-rich supplement, e.g. seaweed meal.

Cure. Dissolve 1 oz. potassium iodide in 3 pints of water, dose the goat with 2½ fluid ounces of this mixture daily for five days. Paint the sores with tincture of iodine. Penicillin injection may also be used. If necessary feed gruels, soft greenstuffs can usually be eaten; hay often not. Before and after handling an animal with this disease the attendant should paint any skin abrasions on his hands with tincture of iodine. The disease may be fatal in man.

MUSCLE-BOUND

Symptoms. Slight stiffness on rising, inability to make or sustain violent exertion, tends to get worse with exercise; no acute pain in joints.

Occurrence. Mainly in young stock on a high level of feeding, over-rich in lime; especially when seaweed meal is fed in quantities exceeding 6 oz. per head. Several of the young stock may be affected simultaneously.

Prevention. Correct feeding and management.

Cure. Stop using seaweed meal; add ½ to 1 oz. fish meal to concentrate ration, or dose with calcium phosphate.

RHEUMATISM

Symptoms. Stiffness, especially on first rising, sometimes acute pain, mainly in the joints, tends to wear off after a little exercise. One member of the flock at a time is affected.

Occurrence. In old goats especially and in younger goats under damp, draughty housing conditions.

Prevention. Correct feeding and housing.

Cure. Forty-eight hours' starvation, four garlic tablets daily,

access to warm water. Thereafter, a light fibrous diet with no concentrates for ten days, and nne garlic tablet daily. Wnrk back to correct diet. This is ratber drastic treatment for what may be a mild complaint, but it is the best cure; if the case is a mild one the cure can be postponed till a suitable stage in lactation, and the diet adjusted to a bulkier standard in the meantime.

ALTERNATIVE TREATMENT

It will be seen from the foregoing notes that a number of the most important goat diseases—e.g. mastitis, entero-toxaemia, rheumatism, laminitis and some forms of pneumnnia—are treated on the basis that tbese diseases are primarily due to the accumulation nf toxins in tbe organs of the goat, the presence nf which provide the conditions necessary for the action of specific disease bacteria. Garlic treatment has been recommended tn aid the removal of sucb toxins, as this method bas been most widely used fnr the purpose.

Now tbe goat is capable nf a daily through-put of digestible nutrients, per 100 lb. of bodyweight, twice as great as that nf cow or sheep. She is tberefore liable to autn-intoxication at a rate twice as high as that of the cow or sheep. She must either prove an exceptlonally unbealtby animal or be prnvided with a compensatory detoxicating mechanism. It is significant therefore tbat tbe goat suffering from pernicious anaemia resulting from cobalt deficiency requires four times as mucb cobalt to cure her as the amount required by an anaemic sbeep of tbe same size. Pernicious anaemia is not directly due to lack of cobalt in the blood of tbe goat, hut lack of vitamin B_{11} which is synthesized by tbe rumen hacteria from cobalt and otber raw materials. Vitamin B_{12}, in alliance witb vitamin B_1 and other substances of a water-soluhle nature, are known to act in a way which suggests that tbey are detoxicants; human need of them, for instance, is in proportion to carhohydrate intake in many cases.

It appears reasonahle to suggest that the high rate of auto-intoxication of the goat when fed to the limits of her appetite, is naturally balanced hy a high capacity for vitamin synthesis; that the main natural detoxicant of the goat is this combination of B vitamins and allied substances with B_{11} and B_1 playing a major role.

On a fibrous diet B_1 requirements will always be met unless there is a heavy worm infestation which grabs the vitamin hefore the goat gets it—the substance of parasitic worms is one of the most vitamin-rich natural foods availahle. But the supply of cobalt for the manu-

facture of vitamin B_{12} is by no means assured. Areas where tbe cobalt content of herbage is inadequate for sbeep are already known to be extensive and are still being mapped; heavy cropping and modern methods of busbandry tend to lower the natural cobalt content of fodder.

It may well be that the use of doses of these vitamins and of B_{12} in particular will be found to provide a more natural rapid and effective detoxicant tban garlic—which is not witbout its disadvantages and lash-back. Tbe vitamins cannot be provided through the mouth as the greater part of them is tben decomposed before being absorbed—they must be injected.

There are no adequate grounds for recommending this metbod of treatment in a work of this kind; but there seem to be sufficient grounds for an interested veterinary surgeon or goat-keeper to try these methods in cases where other methods fail to give satisfaction.

First aid kit for the goat bouse

A sharp knife
2 in. and 1 in. Prestoband bandages
Adhesive plaster
Surgical gauze
Cotton wool
Surgical thread and needle
Boiled brine (or Dettol)
Tincture of iodine
Acriflavine emulsion
Hydrogen peroxide
Linseed oil
Drenehing bottle
Hypodermic syringe
Enamel bowl
Garlic tablets
Tree-bark food
Veterinary penieillin
A goat blanket

The normal temperature of the goat is 102·5 to 103° F.
The normal pulse rate of the goat is 70 to 95.
The normal respiration rate is 20 to 24 per minute.

Chapter 12

GOAT DAIRY PRODUCE

Whether the end product of our goat dairy be fresh milk, cream, butter or cheese, the prime requirement is a supply of clean milk of regular composition.

The cleanliness of goats' milk must inevitably be judged by the standards obligatory on cows' milk. There are, in effect, two standards, 'certified' and 'pasteurized'. If goats' milk is to serve a quality market with particular reference to invalids and young children there is only one standard to be considered—the best.

In seeking to attain the standards laid down for 'certified' cows milk the goat-keeper has two significant advantages and one serious disadvantage.

Advantages: in the first place the milk of the goat naturally has a lower bacterial content as it comes out of the teat, than the milk of the cow. In the second place the conditions under which goats' milk is produced are not subject to the same legal controls as are imposed on cows' milk production; it is therefore permissible to use chemical methods of sterilizing goat dairy equipment instead of the very much more laborious and expensive steam-sterilizing equipment which is obligatory for cow dairymen. These chemical sterilization methods are widely practised in U.S.A. where a far higher standard of hygieoe is maintained than in this country; there is little doubt that the development of tanker collection of milk in this country will lead to the official approval of chemical sterilization methods loog before goats' milk is so far recognized as to be subject to control.

The disadvantage the goat-keeper has to face lies in the character of goat dung. Certified milk standards demand that there should be no coliform bacteria present in a sample one-tenth of a cubic ceotimetre of milk. Coliform bacteria of the type most likely to find their way into goats' milk are not particularly dangerous to humanity; but they are capable of multiplying in the milk at a higher rate thao most other forms of bacteria, thereby souring the milk and producing off-

flavours very rapidly. Coliform bacteria find their way into milk mainly on the vehicles provided by minute particles of dung dust. Cows' dung is far from dusty and if the cow hyre is richly charged with dung dust at milking time, it is a very dirty and sloppily managed hyre. So the coliform bacteria test is a sound criterion of clean cows' milk production.

But goat dung is exceedingly dry and dusty; moreover the goat's need of a warm bed and some freedom of movement makes it impossible to achieve with her the clinical cleanliness of the concrete cow-hyre and the same scrupulous isolation from her dung. Even if we put the goat on some form of insulated and impervious floor, her dung pellets hop about like a packet of spilled peas, here, there, and everywhere—under her feet to be trampled to dust and on to her bed to contaminate her coat.

The cow, who stands belly-deep in the river for half of the summer day, for preference, has no objection to a bucket of water swashing round her legs when a cow-pat goes astray in the hyre. But such hygienic procedure in the goat shed would lower yields all round.

We can therefore assume that the goat house and coat, at the best of times, will have a far higher content of dung dust and coliform bacteria than any decent cow or cow hyre would own.

Some diligent goat dairymaids counter this difficulty by milking into a milk strainer set over the pail. Unfortunately, this precaution seldom has the desired effect. The dust and hair, to which the coliform bacteria are attached, accumulate in the strainer, while the coliform bacteria themselves are power-sprayed off their vehicles by the jet of milk, through the filter and into the milk. So long as the bacteria remain attached to hair and dust there is a reasonable hope of extracting the greater part of them in the dairy filter; once they are separated from their vehicles they are in the milk for good or ill. The use of hooded milking-pails is a help in reducing the amount of hair and dust which comes into contact with the milk; but they are more difficult to sterilize and, at best, they do not bridge the obstacle to hygiene constituted by the goats' dusty dung.

There can be no half measures. No goat house is suitable for producing goats' milk to 'certified' standards. A milking-parlour, which is a useful aid to the production of clean cows' milk, is a prime necessity for the production of clean goats' milk. The milking-parlour need be neither expensive, large, nor elaborate, but it must be separate from the goat house and it must be washable.

Her Majesty's Stationery Office publish a leaflet on cow milk-

parlours. Most of the material therein is directly applicable or readily adaptable to goat milk-parlours. The main points are: an impervious, self-draining floor, coved at its junction with the walls; impervious washable walls to at least 4 ft. height; general construction to avoid horizontal shelves and ridges which will trap dust; facilities for holding and perhaps feeding the goat while being milked. Corrugated iron is too noisy, heat-conducting, and perishable to be recommended, but almost any other material is suitable for the main structure. Fig. 29a shows a sample goat milking-parlour, designed to provide facilities for machine milking. Most types of existing cow milk-parlours are quite suitable for use by goats—only the tandem type presents some difficulties.

The goats will, of course, be brushed down before entering the milk-parlour, but their coats will still be rich in dung dust and coliform bacteria. As the goat offers less room for the milker to manœuvre than the cow, her coat suffers more disturbance in the process of

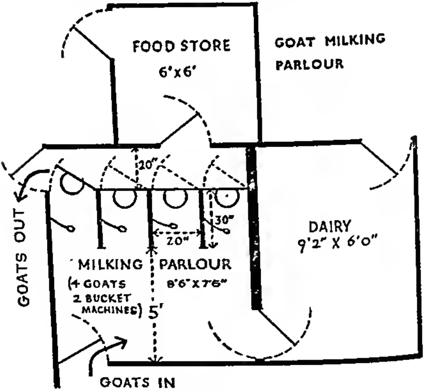


Fig. 29a

milking, so that a relatively clean goat would release more dung dust at milking time than a relatively dirty cow.

There are two ways of dealing with this problem: one or other or both of them must be adopted unless we are going to set ourselves a serious handicap to clean milk production. Firstly, there is no reason why the dairy goat should not be clipped, at least over the area of its coat which is disturbed during milking. Anglo-Nubians of many strains are content with a reasonable modicum of hair and there is no excuse for other breeds to be flapping their dung-dusty locks around in the milking-shed. The whims of the 'fancy' and the show-ring must never be allowed to frustrate clean milk production: if the goat of the show-ring is to participate in commercial milk production and retain her natural coat, a Hoover 'Dustette' will have to become permanent goat-house equipment! And why not?

Secondly, goats can be milked by machine, by which means very little dust reaches the milking-pail. Goats respond exceedingly well to machine milking, but there are some snags. The weight of the standard teat cluster—even when reduced to two teats—is excessive for the goat's udder. The goat-milking machine is accordingly designed with a claw piece that rests on the floor. With no weight at all to hold it down, the teat cluster has a tendency to climb up the teat in the later stages of milking and, in the case of a badly formed udder, to swallow a proportion of the udder. However, given a goat with a clear line of demarcation between teat and udder, with proper supervision machine milking is perfectly satisfactory. The sphincters on the goat's teat are less powerful than those on the cow's and a lower vacuum setting (as advised by the makers of the machine) is required. For an average goat, giving 4 pints at each milking, the total milking time is four minutes per goat, including tying and udder washing, provided a machine is used. In this period a goat can also consume ¾ to 1 lb. of concentrates. One man, with the one machine which he can effectively control while feeding and udder washing, can put through the milking-parlour the twenty to thirty goats which are needed to fill his wage packet in about two hours. With two machines and an assistant in the milking-parlour the job can be done in an hour or slightly less. Six to seven minutes per goat is needed by the hand milker.

The milking machines adapted for goats are of the bucket type. There would appear to be no technical difficulty of much importance in the way of adapting recorder units for goats if the demand arose. But where a flock kept under non-intensive conditions is producing

less than 6 pints average peak yield, and for flocks of less than ten milkers, a hand milker can get through the job more quickly than he can set up the milking machine, do the milking and clean the machine. Specialist goat-keepers do well to consider that many milking machines on small dairy herd farms absorb as much labour in being cleaned as they save at milking; their existence is often due solely to the fact that farmers' wives do not draw the statutory minimum wage.

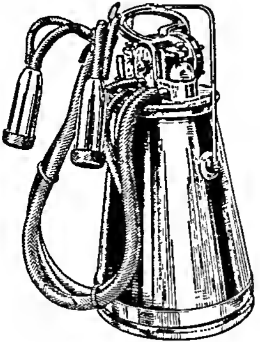


Fig. 29b. Gascoigne goat unit

Adapted from the Gascoigne positive unit comprising positive lid, pulsator, milk and moisture sight glasses as standard features. Teat cups are smaller and clawpiece lighter specially to suit goats. Two-gallon capacity stainless steel pail. Can be operated off any milker vacuum—10 in. is sufficient for goats

But the dairy farmer with a bucket plant has only to exchange the standard cow teat cluster for the special goat cluster, and reset the vacuum control, to reap the advantages of machine milking of goats, with no great alteration in wash-room labour. In such case, irrespective of time-saving, the goat machine may be valuable simply to eliminate dung dust.

In organizing the milking, routine labour economy is most important. When all the labour resources of the farm are mustered at the milking it is most expensive to have them and the machines standing idle, at three-ha'pence a minute a head, while Matilda finishes up her corn ration. Cattle standards can be misleading:

A Friesian cow takes 1·91 minutes to eat 1 lb. of grain.
A Jersey cow takes 2·39 minutes to eat 1 lb. of grain.
A 100-lb. goat takes 5·04 minutes to eat 1 lb. of grain.
A 150-lb. goat takes 4·23 minutes to eat 1 lb. of grain.

Small goats and goats fed large concentrate rations should be fed before or after milking if they are to be milked by a machine, which seldom requires more than four minutes per goat.

In only one other respect does the production of clean goats' milk present special difficulties—the possible presence in the near vicinity of a male goat. It is absolutely essential that no taint of 'billy' come near the milking-shed. Billy owners' sense of smell becomes mercifully blunted in course of time. Unless there is a rigid routine as to the times at which the billy's needs are attended to, and as to what happens to the hands and garments that approach him, his taint will find its way through the best of intentions.

In other respects the factors governing the production of clean goats' milk are fully covered by the massive literature on clean milk production offered to the dairy cattlemen. It would be a waste of space to reprint them here. No one attempting to sell milk should fail to study one of the many cheap and excellent leaflets on dairy technique.

Those who produce milk for sale and follow the advice given above are earnestly recommended to submit regular samples for analysis; local agricultural advisory officers will be glad to give cost-free co-operation in this respect. If the efforts to eliminate dung dust are thoroughly carried out and successful, there is every reason to suppose that local 'clean milk' competitions should never be won by a cattleman if there is a goat-keeper among the competitors.

For domestic use, milk produced by one's own goats is none the worse for the presence of a few coliform bacteria per cubic centimetre. We swallow them by the million whenever we clean the goat house. But since those who drink the milk of their own goats will seldom study dairy textbooks the very elements of hygiene may, and often do, escape them.

Never use for human consumption any of the milk from any goat

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with any disease. Strain and cool milk as soon as possible. Wash all milk-pails, jugs, dishes, etc., as follows:

(1) As soon as possible fill, cover and rinse them in cold water.

(2) Fill, cover and wash them with warm water in which dairy detergeot has been dissolved (but NOT IN HOT WATER—tbe temperature of the water sbould be no higher than that used for the bahy's woollen vest or best nylons).

(3) Rinse in plenty of warm or cold water.

(4) Scald with boiliog water, and DO NOT DRY WITH A CLOTH, but stand upside down to dry on a RACK, not on a sbelf, so tbat the air can get io and the moisture can get out. Unless the milk pails, etc., are kept in a sterile dairy, if you want to he particular or there is disease in your house, scald the pails again immediately before use; alternatively, put them for a quarter of ao hour in an electric oven set at 250°.

It is worth while steriliziog the cans in the oven periodically, for the smell of the can on removal from the oven is a good working test of cleanliness. Should the result of this test prove shocking, or should tbe keeping qualities of tbe milk deteriorate or your regular visitors stop taking milk in tbeir tea, do not waste your time and energies trying to clean the cans with steel wool or 'sweeten' tbem with bleacb but buy a 'milk-stooe solvent' from a dairy supply firm. Whenever a trace of milk remaios in a can whicb comes in contact witb hot or scalding water an invisible film of albumen is formed on tbe surface of tbe can. This film feeds bacteria and taints the milk, but so gradually that the regular consumer is liable to ignore the cbange. This film can he removed effectively only with the 'milk-stone' solvent.

For cheese-making on a considerable scale it is essential, and for fresh milk retailing it is highly desirahle, that tbe milk produced should he reasonahly constant in composition. Some seasonal fluctuations in composition are inevitahle, hut day-to-day fluctuations can he controlled hy regular milking routine and correct milking practice. In addition, hoth these factors have an important influence on yield.

Milking should he at regular intervals—as near twelve hours as may he—otherwise the milk drawn after the longer interval will be relatively low in hutter-fat.

The actual routine of milking will depend upon the standards of hygiene required and individual circumstances. But it must he a rigid orderly routine, involving the minimnm of fuss and hother.

The goat requires at least five minutes' warning that she is ahout to he milked, in order that the operative sphincters and valves in the

udder may release all the milk available when required. During the ensuing five minutes there must be no distracting novelty in procedure, or the 'let-down' will be held up. There must be no undue delay once the process is under way, for if the goat is disappointed in the expected moment of her milking the operative sphincters impatiently close again.

This mechanism must be remembered when arranging the routine for milking the first goat; the fact of the first goat being milked is adequate warning to the next on the list, but the first goat is entitled to some warning herself. Where udder washing and drying is practised, this procedure will constitute fair warning. Where it is not practised some routine which will command the goat's attention must be incorporated in the programme.

The goats must be milked in a set order. In a flock which enjoys some measure of social organization the order should be that of the social hierarchy—an order which a little observation of the flock on range will soon reveal. A flock queen will not give of her best if a couple of goatlings are milked before her. Her protests will be broadcast to the whole flock, who will then be more concerned with her complaints than with the milking routine.

An earnest silence upon the part of those doing the milking is not necessary. Peace in the milking-shed there should be; but peace and silence are not synonymous. Men and women have not been singing at the milking for the past thousand years or so, merely to exercise their lungs and lose milk. A consistent singer can make the milk drip from the goat's or cow's teats merely by singing the accustomed songs. For a goat distracted by a breach of routine or a tender udder, the accustomed song or the regular patter of soothing nonsense is the best aid to let-down available. There is every reason for excluding strangers from the milking-shed, but the silent milkmaid is a grim, unhistorical figure with little to recommend her.

The one sound which is quite unforgivable in the milking-shed is a sneeze: apart from hygienic considerations this sound resembles the goat's alarm signal and invariably (and literally) causes consternation.

The actual process of milking is a knack which is quickly acquired if the basic principles are understood. Anyone who is accustomed to milking cows must realize that they are handicapped by a habit of milking unsuitable for the goat and pay particular attention to the principles of goat milking.

Grasp a teat lightly in one hand and press the hand gently upwards towards the base of the udder, so filling the teat with milk. Then

close the index finger tightly around the neck of the teat, with the hand still pressing gently upwards. This action will trap the milk in the teat. Now close the other fingers in succession tightly around the teat, so forcing the milk down and out. Release the grasp of the teat and relax the upward pressure. Then repeat the process with the other hand and the other teat.

As the udder empties the upward pressure of the hand becomes firmer and the initial movement of the milking hand becomes a gentle upward punch. When the flow begins to subside, let go both teats and with both hands gently massage from the top and back of the udder down towards the teats, two or three times. Continue milking until the flow subsides once more; repeat the massaging movement —and so on until no more milk is drawn. The goat should be milked right out to maintain butter-fat content of the milk and to sustain the yield—but 'stripping', as practised on the cow, will distort a goat's udder in a very short time.

Many goat-keepers are bad milkers; a novice may be better advised to follow this advice rather than doubtful example.

In a goat with very short teats it may be impossible, especially for a man, to get more than one finger of the hand around the teat. In this case, on the first upward pressure of the milking hand, trap the neck of the teat between the index finger and the knuckle of the thumb; then extract the milk from the teat by rolling the index finger down the teat while keeping the teat pressed against the thumb.

Men are usually rather handicapped in milking goats for, as often as not, the teat is too short to accommodate all four fingers of a large hand—which means more work, and more fatigue for the other three, and less speed. There is a strong temptation, in the circumstances, especially after the first flush of milk has been drawn, to 'stretch a point' and grasp a portion of the udder above the neck of the teat, so as to bring all four fingers to bear. This procedure is dangerous, for it is quite easy to crush the substance of the udder and force a portion of it down into the teat canal with disastrous consequences.

It is of no importance whether the goat is milked from the right side or the left, provided she is milked consistently from the same side. A goat with an udder of reasonable shape and capacity cannot be milked from behind without great difficulty and damage to the udder. Scrub goats with low yields and goats with cleft pendulous bags can be so treated without harm or trouble. The advantages of this method will be conspicuous to the intelligent beginner. A restive goat cannot kick over her bucket or put her dirty foot in it when

milked from this angle. She can, however, drop dung pellets into the bucket, and even make her water into it if the milker is insufficiently alert. The method, though popular with Mediterranean goat-keepers, is not recommended; but really evil-tempered goats are exceedingly difficult to milk in any other way.

The nervous, fidgety, 'ticklish' goat, usually a first kidder or one suffering from udder injury, can be dealt with by milking with one hand and gripping the goat about the thigh with the other, so as to encompass the hamstring. Compressing the hamstring will smother a kick, even after it has got under way.

More violent objectors may need to have both hind legs, or all four legs, strapped into position on the milking-stand. Even then it may be necessary to sling a strap under the goat's belly to stop her lying down. But when this stage of belligerence has been reached, unless the goat has a really painful excuse for her behaviour, it is better to abandon mechanical methods of control and resort to psychological methods (p. 105).

A great deal of trouble at milking time can be avoided if goatlings are accustomed to have their udders handled and massaged long before they are due to kid. The first step in milking a nervous and fidgety goat should always be to stroke and massage the udder until she quiets down: talk to her as you do so and keep on talking (or singing) as you start milking.

Another great aid to milking without tears or spilt milk is to let the kid pioneer the job for the first four days of lactation which are the most painful and nerve-racking for the new milker. Most seasoned goat-keepers prefer to put their goats on to a raised platform to be milked; the beginner may prefer to keep the goat on the floor where he can exercise firmer control; but with the goat standing at a higher level than her milker there is less disturbance of her coat and the milk is cleaner; and latterly, when we squat down to goat level, we all tend to creak.

Goats are generally easier to milk than cows, and the worst of them, though tiresome, cannot do any hurt to anyone. The problems created by the difficult milker have been treated in some detail because this is an aspect of reality which goat literature usually tends to gloss over.

GOATS' MILK RETAILING

Goats' milk retailers are the main advertisers of the industry and

should never forget the fact, in their own interests and those of their colleagues. Advertisement may be good or bad; a system of accreditation for goats' milk suppliers, voluntary and under the control of the British Goat Society or local authorities, would probably be of more value to the industry than milk recording.

Provided that the milk is hygienically produced, the essential point is that it should be distinctively labelled. There is more sales punch in the bottle of still sweet goats' milk, standing beside the bottle of sour cows' milk of the same age, than there is in a whole-page 'spread' in a national daily newspaper. Clean goats' milk will keep a great deal longer than the best of cows' milk—my personal record, with milk produced under conditions of scullery dairying, was ten muggy July days of a camping holiday.

By appalling misfortune, authorities, who should know better, have sponsored a system of labelling goats' milk with printed cardboard bottle plugs. These plugs form the bottom of a small basin at the top of the bottle in which accumulates all the dirt collected in the process of distribution; if the bottle is left on a doorstep, the little basin collects rain from a more or less polluted atmosphere, and any contributions the birds of the air and the beasts of the pavement choose to add to it. In nine cases out of ten the consumer tips and dips this rich culture into the milk in the process of extracting the plug. The fact that plug-top bottles are used for the distribution of the lower qualities of cows' milk by some of the less prosperous dairy firms is no justification for using them to distribute goats' milk. Metal caps of a distinctive colour (e.g. blue or green) are the only clean and satisfactory bottle seal and it is to be hoped that the British Goat Society may register a nationally recognized cap colour for the use of accredited producers. Printed wax cartons are clean, give good publicity and save bottle washing and collection charges.

The seasonal variation in milk supply, which is such a handicap to goat dairying, can be mitigated by stretching the natural breeding season to the limit, by 'running through' (biennial breeding), and by out-of-season breeding; but the variation must remain wider for goats, with their limited breeding season, than for cows who breed all year round. It is some compensation that goats' milk, unlike cows' milk, can be satisfactorily stored in a deep freeze.

Cows' milk will not freeze successfully, because the quick rise of cream causes the formation of large fat globules in the 'reconstituted' liquid. Goats' milk will freeze successfully, provided (a) that it is cooled and frozen immediately after milking, (b) that it is maintained

at a steady 0° F., (c) that it is defrosted slowly. Carelessness at (a) results in fat clusters; carelessness at (b) or (c) results in flaky curd.

Freeze in polythene bags, not more than two-thirds full, to allow for expansion. Date every bag and allow a cold-store life of up to three months.

There is a higher incidence of off-flavours in goats' milk than in cows' milk; most of them can be prevented by strict attention to the points of dairy hygiene mentioned above. But there is a peculiarly bitter flavour which can occur quite suddenly in the milk of any goat, however scrupulously the dairying is managed. This is thought to be caused by faulty fat metabolism, due to slight anaemia, acetonaemia, or diabetes, and is especially common in newly kidded goats. The cure is to be found in Chapter 11; here it is to be noted that the milk of all goats should be tasted regularly before being offered for sale.

GOATS' CREAM

This is a relatively easy form of produce both to make and to market. If the skim milk can be fed to remunerative stock—calves, pigs, orphan lambs, pedigree pups and kittens, mink, pedigree chicks, etc.—the cream can be sold to compete in price with cows' cream. It will always compete in quality: children prefer goats' cream because it is more digestible; housewives prefer it because it whips to greater bulk. In flavour it is not readily distinguishable from cows' cream; but unless anatto is added, goats' cream is dead white in colour.

The prime requirements of the cream producer are: (a) a remunerative outlet for skim milk; (b) a strain of goats with high butter-fat milk; (c) a goat diet rich in iodine. For mass production it is also essential to have a good separator: not all separators are satisfactory for separating goats' milk—Alfa-Laval and Lister separators give good results; the farm (over 2 gallon) models give better results than the smaller models. A fine setting of the cream screw is necessary in all models, for the fat globules of goats' milk are small and slow to respond to centrifugal force. If in doubt whether a given separator or screw setting is giving satisfactory cream extraction, run the separator at full speed and let the milk tap run at half or quarter its capacity: if you get a better cream output per gallon in this way your cream screw setting is too wide or your separator is not readily adaptable to goats' milk. A cream screw setting or a separator which gives good results at the start of lactation may give poor results later on, for the size of the fat globules in the milk decreases as lactation advances.

The type of cream produced must depend on the taste and nature of the market; the creams which are subjected to much heat treatment before or after separation do not whip satisfactorily and when they sour they produce foul flavours. The creams subjected to little heat treatment do not keep so well, but if cleanly produced they sour pleasantly, and for whipping they are superlative.

Thin cream. Run the milk through the separator while still warm. If the milk from more than one milking is used, it should be pasteurized when new by holding it to 180° F. for thirty seconds, then cooled quickly and stored in a cool place until required. Before being put through the separator, the milk should be again raised to 180° F. and rapidly cooled to 100° F. before being separated. At least part of the milk used for thin cream production should be 'warm from the goat' when put through the separator, otherwise the cream will not sour pleasantly.

An extraction rate of 1 to 1¼ pints from a gallon of milk will give cream with a fat content comparable to that of most of the cows' cream on the market. In some districts this product is termed 'ream', the term 'cream' being reserved for:

Double cream, which is produced in the same way but with a cream screw setting to produce ¾ pint per gallon of milk.

Thick granulated cream. Proceed as for double cream and immediately cook in a bain-marie or double saucepan for twenty minutes at 180° to 200° F. Cool rapidly and place in a refrigerator for twelve hours at least. This form keeps extremely well and is ideal for eating with fruit; when whipped it forms butter very rapidly, but the butter has poor keeping qualities. Still the best form of cream for long-distance marketing, it would stand summer-time transport from the Hebrides to London.

Devonshire cream. Cool fresh-drawn milk quickly and leave it to stand in shallow pans in a cool place for twelve to twenty-four hours, according to air temperature. Then place the pans on slow heat until the surface cream starts to wrinkle and crack; do not let it boil. Cool again quickly and skim with a skimmer or saucer. The resultant cream can then be sold for quick consumption or heated in a bain-marie or double saucepan to 180° F. for thirty seconds and re-cooled, for better keeping qualities.

BUTTER

Butter is not easily marketed at an economic price owing to the competition of imported cows' butter and the operation of the food subsidies. In large cities where there is a significant foreign population of Greek or Cypriot extraction, and specialized provision stores catering for them, a regular market for goats' butter may be developed—goats' butter is held in special reverence by these peoples and traditionally occupies an honoured position on the menu for festal occasions.

But well-produced goats' butter is such a superlative product that, once it has been savoured, the best of cows' butter becomes, in comparison, uninteresting grease. The goat-keeping household will inevitably demand it.

For occasional production the flavour of the butter can usually be safely left to natural souring organisms, provided there is a high standard of dairy hygiene throughout. But for regular production it is necessary to control the souring organisms and use a dairy butter starter.

Natural-sour butter. Separate the milk as for double cream, adding fresh batches of cream daily, or allowing the cream to stand until it smells slightly acid but does not taste sour. Take the temperature of the cream with a dairy thermometer (a cheap implement that saves an immense amount of work in butter-making). Bring the temperature of the cream to about 57° F., by standing the can in warm or cold water. If the air temperature is above 60°, 56° is warm enough for the cream; if the air temperature is below 50°, bring the cream to 58° or 59° F. Put the cream in the churn, and churn for about fifteen to twenty minutes—an egg-whisk and a bowl make an adequate churn for small quantities. As soon as granules appear in the thickened cream—the noise of churning will change its note at this stage to a 'hollower' sound—add a teacup of water for each 1½ pints of cream. If the air is warm (above 60° F.) the water should be cold, if the air is cold the water should be at about 60° F. Continue churning till the butter granules are the size of peas, then strain off the buttermilk, and wash the butter in successive rinses of cold water until the water runs clear. Then, and only then, gather the butter granules into one lump and start working the lump in further rinses of cold water until no further buttermilk is exuded. Then take out the butter and

work it on a board with wooden pats (Scotch hands) which have been soaked in brine, to express all the water. Make up into shapes and leave to stand twelve hours in a cool dairy.

If preferred 'salt', dairy salt should be added to the last rinse of the butter granules and the butter granules left to stand in this for fifteen to thirty minutes.

If difficulty is experienced in getting the butter to break, a not uncommon trouble when the fat globules become very small in late lactation, use the alternative method.

Salted cream butter. This method is specially designed to ensure the production of well-flavoured butter from small quantities of cream accumulated over a period of a week. The essential factor is that the daily accumulation of cream should be reasonably uniform —say a pint a day.

Extract the cream as for natural-sour butter. To the first batch of cream add 9 oz. of dairy salt per lb. of cream, or 11 oz. per pint; store in a cool, dust-free place with good ventilation; each day stir in another batch of approximately the same volume as the first, but no more salt. At the end of the week churn as for natural-sour butter. In cool conditions the accumulation can continue for a longer period but the amount of salt used must be adjusted so that the amount of salt added to the first batch is 8 per cent of the weight of the final accumulation of cream. The principle of the system is that under normal dairy conditions cream will not sour if the salt content is over 8 per cent.

Starter-sour butter. Separate the milk as for double cream. Place the cream in a double saucepan or bain-marie and heat to 180° to 200° F. for twenty minutes. Cool rapidly and place in a refrigerator for twelve hours. If no refrigerator is available heat to 180° F. for forty minutes and cool rapidly, as low as water temperature will take it. Then warm the cream to 50° F. and add dairy starter. Cover and leave to stand until the cream smells acid. If a full-flavoured butter is liked the cream may be left until it tastes slightly sour (but only when dairy starter is used). Then proceed as in previous method.

If colour is required in either butter or cream the anatto should preferably be added to the milk before separation: it may be added to the cream before churning.

dust-free surroundings, and the culture is kept at the correct temperature during the incubating process. Eventually the starter will lose its vigour and flavour and a new starter will be required.

If starter is not available for use in any of the recipes given below, double the recommended quantities of buttermilk or naturally soured milk, or ten times the quantities of milk held over from the previous morning, may be used instead of starter—with the risks of failure implicit in the use of uncontrolled ripening organisms.

Rennet. Only cheese-making rennet of a renowned brand is suitable. The grocer's junket rennet is quite useless.

Anatto. A little colour improves the appearance of most cheeses. *Cheese Anatto* only should be stirred into the milk ten minutes before renneting.

Salt. Use dairy salt only.

The Cheese Milk. With a few specified exceptions fresh whole milk is required for all the recipes given. A high standard of dairy hygiene is required to produce good cheese milk. Dirt bacteria cause foul flavours. If there is any doubt about the quality of the milk it is better to drink it than use it for cheese-making. Pasteurization of the milk alters the character of hard cheese and is responsible for most of the unpleasant and soapy characteristics of the worst factory-made cheese. However, where milk has to be held over from day to day it is preferable to pasteurize than to risk the milk becoming over-ripe. When pasteurizing for cheese-making hold the milk at 145° F.—no higher—for thirty minutes.

The first four recipes given are suitable for goats' milk or for a mixture of cows' milk and goats' milk. The remaining recipes are for hundred-per-cent goats' milk.

The Crofter cheese. A semi-hard cheese of mild flavour maturing in about four weeks and yielding about 18 oz. per gallon; requires about 2 gallons of milk. This cheese is of better keeping quality and flavour than that produced by the majority of simple cheese-making recipes.

Equipment. A tub or pail, a long bread knife, two 15-in. squares of smooth cotton cloth, a perforated steel mould 5¾ in. high × 4 in. diameter, three weights of 28 lb. each—or a 6-ft. plank with one end hinged to the wall and a 28-lb. weight on the other. (This exerts a pressure of 28 lb. at the weighted end, 56 lb. at 3 ft. from the weighted end, and 84 lb. at 4 ft. from the weighted end, when the plank is kept horizontal.)

faces to the inside of the mass. A 7-lb. weight placed on top of the bundle will assist matting.

At the end of the hour, test the curd against the hot poker again. When the threads so formed reach half an inch in length the curd is ready for salting. Break it up into walnut-sized pieces, add a good tablespoonful of dairy salt, and stir the salt into the curd for a minute. Bundle up the curd again, leave it for five minutes, and give it a final stir before packing into the mould. Do not let the curd get cold.

Warm the mould in tepid water, and press the curd into it by handfuls, pressing just hard enough to cause a little whey to ooze out. Finish by heaping the centre and placing the lid in position. Apply 28-lb. pressure and leave for an hour. Then turn the cheese in the mould, inserting a fresh, dry smooth cloth as a liner, apply 56-lb. pressure and leave till next morning. Turn the cheese again the following morning, renew the cloth, and apply 84-lb. pressure. The same evening or the following morning the cheese should be bandaged.

Rub the cheese with lard and apply cheese-cloth caps to the two ends. Then sew a wide over-all bandage round the cheese, trapping the cap at either end.

Keep the cheese for four weeks at least in warm weather, a little longer in cold weather, in cool room temperature (55° to 60° F.). Turn it daily; if mould starts to form, wipe it away with a cloth soaked in brine.

The times given here should be right for a cheese made with mixed milks: when the proportion of goats' milk is higher than 50 per cent, the times given may be slightly shortened—but the heating of the curd must not be speeded, especially in the earlier stages.

Beginners at cheese-making will find a Smith's 'Pinger' a great aid in timing.

(This recipe is the most ambitious given here and is the most suitable for production for a regular market.)

Little Dutch type. A softer and more open-textured cheese than the Crofter, with less flavour. The quality of this cheese is even more dependent on the quality of the cheese milk.

Equipment. As for the Crofter Cheese.

Procedure. Prepare the cheese milk as for the Crofter, but raise the temperature of the mixed milks to 90° F. before renneting. Rennet the milk half an hour after adding the starter, using 1¼ teaspoonfuls to a wineglassful of cold water. Otherwise proceed as for the Crofter,

but the curd will require a little longer before it is ready to be eut. In cookiog the curd, raise the temperature to 105° F. io ooe hour, the jugs of whey should not be beated above 105° F. for the first half-hour, nor above 110° to 115° F. for the seeood balf-hour. Once the temperature of 105° F. is reached, stir the curd for a quarter of an hour, let it settle, and strain off the whey immediately. As we do not want to bundle the curd in this case, it is better to bale off some of the wbey aod decaot the rest. Immediately add 2 heaped dessertspoonfuls and 1 level dessertspoonful of dairy salt aod a pioch of saltpetre, stir io as for the Crofter. The cbeese mould should be at the same temperature as the curd, whieh is best aebieved by placing the mould io the straioed whey; the eurd is paeked ioto tbe mould as quiekly as may be after the mould is removed from the whey. Pressing, turniog and bandagiog is earried out as for the Crofter.

Typical 'little Dutch' moulds can be used for this eheese and, provided a good starter is used, the cheese milk can be pasteurized without detraeting from the charaeter of the cheese in this case. Unless the cheese milk cooforms to the bighest standards, it is safer to pasteurize.

Wensleydale cheese (Lady Redesdale's recipe). Use 2 gallons of milk for 2 lb. of cheese. Heat milk to 82° F. Add one teaspoonful of rennet mixed with 5 teaspoonfuls cold water, and stir for half a minute. Leave one hour.

Cut the curds ioto ½-in. cubes, as for Crofter cheese. Stir geotly for five minutes with the hand.

Raise the temperature of the curds to 86° to 90° F. in the course of twenty to thirty minutes, by standing the curd bueket io a larger vessel of hot water and stirring constantly. When the eubes of eurd are firm and 'shotty', leave to staod for teo minutes. Drain off the whey, put the curds in a cloth and squeeze out the whey. Lay a 10-lb. weight on the bundle of curd and leave for ten minutes. Break the curd and turn the cold faces inwards, bundle up and replace weight for a further ten mioutes; repeat this last process. Then break up the curds by hand and salt to taste. Leaving the eurds in the cloth, plaee cloth and curds in a mould, fold the top of the cloth flat and apply a 10-lb. weight. Turn daily for three days, replacing the weight each time. After three days, remove the cheese from the mould, place it on a shelf io a cool airy place, turning it daily. It is ripe in three to four weeks.

Brie. (Recipe from a long-established Anglo-Nubian goat dairy in Eire.)

Bring 2 gallons of perfectly fresh, clean milk, preferably warm from the goat, to 83° F. Mix 2 c.c. cheese rennet in 10 c.c. of water. Stir into the milk. Leave to stand for two hours.

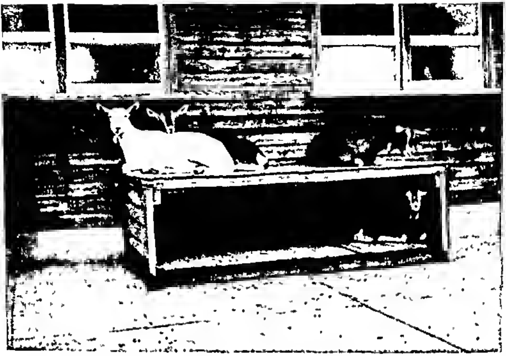
Ladle the curd into hoops, 10 in. in diameter and 3 in. high, standing on a straw mat on a draining-board. Allow to drain for twenty-four hours, or until the curd is firm enough to hold its shape without the hoop; sprinkle salt on the upper surface of the cheese and leave for another twenty-four hours. Turn the cheese on to a fresh straw mat and rub salt into the second side. In a few hours turn again and leave to ripen.

Turn the cheese each day in a dry well-ventilated atmosphere. In about eight days, moulds begin to grow on the surface; the cheese should then be transferred to a dark cellar with little ventilation and with a temperature around 55° F. The ripening is brought about by the moulds, which grow on the surface, diffusing enzymes into the cheese. If conditions are not right for the moulds, the cheese will spoil; mould growth is the key to the operation. The cheese should ripen in two to four weeks, by which time it should have a semi-liquid or waxy centre.

Pont L'Évêque. One of the finest of the French mixed-milk cheeses, with the consistency of boiled white of egg, mild flavoured and slightly sweet, it is probably the best suited to the popular cheese taste of this country. It is, however, very difficult to obtain in any but the larger cities. Traditionally, it is made with 25 per cent goats' milk, but a higher percentage will not go amiss. Yield: two cheeses about 5 in. square and 2 in. deep, weighing 15 oz. each, from 1¾ gallons of milk.

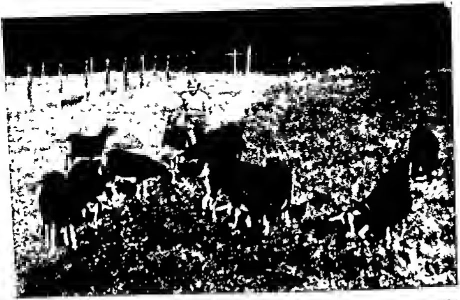
Equipment. A 2½-gallon pail for the cheese milk, a sharp-edged skimmer. A large tub or dairy sink, in which the pail can be immersed (not necessary in warm weather); a bread knife for cutting the curd; 2 yd. of 36-in. cheese cloth; straw or bamboo mats, 1½ in. × 8 in.; draining-boards 14 in. × 8 in.—preferably four mats and four draining-boards for each pair of cheeses, but two will do. Two steel moulds, square with rounded corners, 4¾ in. square × 2¼ in. deep; a draining-rack about 30 in. × 12 in. with ⅜-in. spars set about ½ in. apart. (All standard cheese-making equipment obtainable from dairy suppliers.)

Procedure. Strain the morning's milk—1¾ gallons—into the cheese

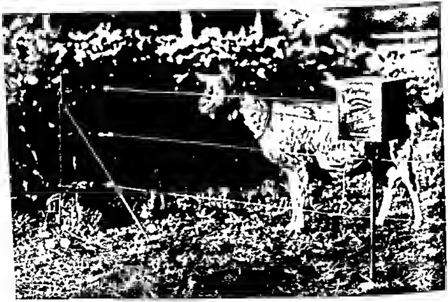


24. A kid sleeping box—a detail of management which helped the white kid, Malpas Melba, to establish a world record

25. Udder washing and machine milking produce clean milk from the hairiest goat



26. Mr. Egerton's Malpas B A.s enhance their bloom in a field of lucerne (alfalfa)



27. An electric fence is all that stands between a Toggenburg temperament and a field of kale. Note the heights of the three wires

pail; adjust the temperature to 92° F. and place the pail in the tuh or sink half-filled with water at 94° F. Or work in a warm draughtless room during warm weather. Add 2 drops of starter and 15 drops of anatto, stirring in each in turn. Dilute half a teaspoonful of rennet in half a wineglassful of cold water and add this to the cheese milk; stir for five minutes. Cover the pail with a cloth. Leave for forty-five minutes, hut in cold weather remove a little of the water in which the pail is standing every quarter of an hour, and replace with water at ahout 94° F. The temperature of the water may he allowed to drop, hut no quicker than it would drop on a good spring day.

After the forty-five minutes, test the curd for cutting as in the Crofter cheese; it may require up to sixty minutes hefore it is ready; if it takes any longer the cheese milk has not heen kept sufficiently warm. When the curd is ready, cut it into 1-in. square columns, and then cut diagonally through the squares, once only, to give triangular columns with 1-in. sides. Leave for ten minutes.

Then, with n skimmer, ladle the curds in ¾-in. slices into a previously scalded straining cloth spread over the sparred rack. Fold the ends of the cloth over the curd, cover with another dry cloth and leave for half an hour.

Open the cloth and quickly cut the curd into 3-in. squares. Fold back the cloth and re-cover with the dry cloth. Leave for nnother half an hour.

Take one corner of the folded cloth and bind it tightly round the other three, bundling the curd slightly in the process. Re-cover with the dry cloth. Leave for a quarter of an hour. Tighten the hundle and turn it upside down, with the knot underneath. Leave for a quarter of an hour.

Place the two moulds together on a scalded straw mat and the straw mat on a draining-board. Then open up the curd, hreaking it into strips and small pieces as you transfer it into the moulds. The curd lying against the side of the mould should he firmly pressed against the side; as each layer of curd is laid, sprinkle it with dairy salt, using a heaped tahlespoonful of salt to each cheese.

When the moulds are filled, cover them with a scalded straw mat, with a draining-hoard on top of that. Now comes the heginner's anxious moment. Grip the two boards hetween the fingers of hoth hands and turn them over so that the bottom of the cheese is now uppermost. Repeat this process at ten-minute intervals for the next hour and once more hefore you pack up for the night.

Leave the cheeses in a cool airy room, turning them in the same

way each day; it is preferable to change the top mat and draining-board for a fresh and scalded pair if the weather is warm and muggy. After four days from the making of the cheese, remove the moulds. Smooth the sides of the cheese with a knife to fill in any crevices, lay the cheeses on a dry muslin and turn them each day until the surface is quite dry—about a fortnight if conditions are favourable.

Now wrap each cheese in greaseproof paper and wrap each pair of cheeses, or preferably each four cheeses if you have them, in a cheese cloth, scalded and dried. Place the bundles so that the cheeses are lying on their narrow sides, on a latticed shelf or baking-tray in a cool airy room. Every day turn the bundles round so that the cheeses lie on another part of their sides; every alternate day open the cloth bundles and turn the cheeses so that the side of the cheese facing inwards now faces outwards. If there are four cheeses in the bundle, move the inside ones to the outside.

Ten days after the cheeses are wrapped they should be unwrapped completely and any mould growth on them wiped off with a cloth soaked in boiled and cooled brine. A cheese with much mould growth on it should be dipped in the brine solution and allowed to dry before being re-wrapped in clean paper. If, while turning, any mould is noticed on a cheese at an earlier date, it should be treated in the same way.

The cheese should be ripe two to four weeks after wrapping and is best eaten within the following fortnight—hence the reason why the cheese is not widely imported.

The Mont d'Or. France's most popular 100-per-cent goats'-milk cheese is made in a very similar way, but by people who apparently attach no particular value to a fifty-hour week. I have been unable to obtain a detailed recipe, but the following may provide early risers with a basis for experiment.

To 2 gallons of fresh clean milk at 82° F. is added 1 drop of starter and 4 drops of rennet diluted in 2 teaspoonfuls of water—each being thoroughly and separately stirred in. The cheese milk is kept in a warm place and the curd is ready for cutting in about eight hours or a trifle longer. The curd is then cut as for the Pont l'Évêque and is strained in a 9-in.-long, conical strainer for four hours, no attempt being made to conserve the heat of the curd. Thereafter the curd is packed into circular moulds a little over 4 in. high and about 3 in. in diameter, with 2 heaped tablespoonfuls of salt sprinkled between the layers. A scalded condensed milk tin with the rims removed

would seem to provide an experimental mould. The moulds are placed on and covered by the same arrangement of straw mats and draining-board as the Pont l'Évêque and the cheeses are frequently turned in the same way. After three or four days, when the cheese can hold its shape without the aid of the mould, the mould is removed and the cheese is rubbed with salt and dried for a further few days on clean muslin laid across a slatted rack or baking-tray. When sufficiently firm, each cheese is completely enveloped in a cheese bandage or wicker basket and hung up to dry in a cool airy room. The cheese ripens about ten to fifteen days after leaving the mould in the summer of central France, probably a little longer in our climate.

With a mould of this height a few elastic bands strategically stretched between the draining-boards would appear advisable.

Ross-shire crowdy butter is not, strictly speaking, a cheese as we know it, but is a modernized version of an eighteenth-century Highland recipe for a curd and butter mixture, based on the use of goats' milk curd and cows' milk butter. It produces a mellow, highly flavoured product somewhat akin to some of the Flemish cheeses.

To 1 gallon of fresh milk at 90° F. add ½ pint of starter, stir thoroughly and leave in a warm place for six to twelve hours, when the whole will have become a smooth, creamy curd. Heat to 110° F. by standing it in hot water and stirring; maintain this temperature for half an hour to an hour, stirring continuously until the curd hardens sufficiently to drain off the whey. When the whey has been drained the curd is washed with sufficient cold water to reduce the temperature to 70° F., and strained through a cloth. The cloth containing the curd has its four corners tied together and is hung up to drip for an hour or two, when the curd should be of firm pasty consistency.

The curd is then thoroughly mixed with 1 heaped tablespoonful of salt and ¾ lb. of butter. A scalded wooden box 7 in. long, 1½ in. wide and 4 in. deep is lined with two strips of cheese cloth that have been scalded in boiling brine, the one strip being 1½ in. wide and 23 in. long, the other 7 in. wide and 12 in. long. The curd and butter mixture is rammed into the box tightly, with particular attention to filling the bottom corners, and the loose ends of the cheese cloth are turned over to cover the top of the mixture. Any space remaining at the top of the box is packed with salt, a lid is fixed and tied firmly down and the box is stored in a cool airy place for a month to six weeks. A month is sufficient for the first trial.

If this recipe is cut short after the salt is added to the curd, without

the hutter, ynu have the recipe for crowdy or cottage cheese, which must be eaten within a few days of making. It is, incidentally, the better for having the hutter worked in, even if it is tn be eaten fresh. Skim milk can be, and frequently was, used for this recipe.

It is a pity tn waste anything, and whey may he made intn Norwegian whey cheese by the simple but extremely labnrious process of evaporating it nn low heat, stirring at frequent intervals until it has reached a creamy consistency and thereafter stirring it continunusly until the consistency becomes pasty. It is then spnnned intn greased howls and allowed tn conl. When cool it can be tipped nut on tn a plate. It is greyish-brnwn in colnur, with a concentrated sweet-salt-snur flavnur, is highly nutritious, and commands a restricted but enthusiastic market.

Chapter 13

THE UNIVERSAL FOSTER MOTHER

To the supreme honour of a place in the heavens, among the signs of the Zodiac, the Greeks elevated three of their domesticated animals: the Bull who drew their ploughs; the fleecy Ram who clothed them; and Capricorn the Goat. The name of the goat who earned this honour for her species was Almalactea—'Foster-milk'. Her constellation still brightens the twentieth-century sky.

While relatively few of the newly born of other species can be satisfactorily reared on cows' milk, however modified, there is probably not a single species among the larger land mammals the young of which will not thrive on suitably adjusted goats' milk. The reasons for the high digestibility of the constituents of goats' milk have been explained in Chapter 3.

The purpose of the present chapter is to consider the adaptation of this highly digestible food to the peculiar needs of the various species of farm livestock, and to suggest how Almalactea can turn an honest penny for the twentieth-century farmer.

It is generally accepted that the composition of the milk of each species is ideally adapted to the growth pattern of the young of the species, and that any other milk composition will represent a departure from the ideal.

In other words, goats' milk will be entirely suitable for youngsters of other species which grow at approximately the same rate as the kid: for those that grow faster it will prove too weak; for those that grow more slowly it will prove too strong.

It is perfectly true that members of the medical profession are, for the most part, convinced that cows' milk, which is designed to suit the fast growth rate of the calf, is perfectly suitable for feeding the slow-growing human infant. But this matter has already been treated in Chapter 3, and here it is perhaps sufficient to point out that farmers are concerned with the economic life history of their stock, while doctors are in practice primarily concerned with resolving

immediate problems, and are seldom able to test the loog-term effects of their recommendations. There is a massive collection of scientific evidence to sbow that all young farm stock, if fed a diet too ricb in digestible protein, are liable to mineral deficiency disease sooner or later.

No one has any doubt that all youngsters must be fed a diet sufficiently ricb to maintain normal growth rate, if they are to be healthily reared.

Table 3 sbows the comparative composition of the milk of the various species of domesticated animals, including women (!) Table 4 sbows the adaptation of goats' milk which is required to produce a milk as nearly as possible ideal for the rearing of various classes of farm stock. It will be seen that this adaptatioo is quite satisfactory for calves, lambs and foals; it is not so good for puppies, but valuable orphan pups can almost always be reared on this mixture, which gives them insufficient protein, to the stage at whicb they cao take eoough of the milk to provide all the proteio they need. For rearing kittens from birth goats' milk is the best substitute for cats' milk available, but will only rear the stronger members of a stroog litter. Few people will be unduly coocerned at this lapse from perfection.

TABLE 3. COMPARATIVE COMPOSITION OF THE MILK OF VARIOUS SPECIES

(Percentage)

Species	*Water*	*Fat*	*Sugar*	*Casein*	*Other Protein*	*Ash*
Goat	86·2	4·5	4·08	2·47	0·43	0·79
Cow	87·3	3 67	4·78	2 86	0·56	0·73
Sheep	79·46	8·63	4·28	5·23	1·45	0·97
Mare	89 8	1·17	6·89	1·27	0·75	0·30
Donkey	89·88	1·5	6·09	0·73	1·31	0·49
Dog	75·44	9·57	3·09	6·10	5·05	0·73
Cat	81·63	4·49	4·79	3·72	3·30	0·58
Pig	83·23	4 5	4·2	7·3		0·77
Woman	87·4	3·0	6·5	·04	0·7	0·25

TABLE 4. ADJUSTMENT OF GOATS' MILK FOR THE FEEDING OF THE NEWLY-BORN OF FARM ANIMALS

Species	*First Ten Days*	*Thereafter*
Calf	Whole milk to appetite in four feeds per day.	Whole milk up to 1 gallon per day in two to four feeds.
Lamb	Whole milk with one ouoce of thin cream added to each half pint to appetite in four feeds per day.	Whole milk up to 2 piots per day for hill lambs and up to 4 pints per day for other breeds in four feeds per day.
Foals (including donkey foals)	Half-and-half milk and water with 3 level tablespoons lactose (sugar of milk) to each pint of *milk*, or 2½ level tablespoons sugar to each pint of *milk*, and 1 teaspoon lime-water to each pint of *mixture*, io four feeds of up to 1 pint.	The same, fed to appetite in four feeds a day. At 2 months the proportion of milk can be gradually increased up to 75% of mixture.
Pups	A teaspoon of thin cream in a tablespoon of whole milk at eight feeds per day; feed to appetite.	The same at six feeds till 3 weeks. Then whole milk to appetite in four to six feeds.
Kittens	Whole milk in six to eight feeds per day.	The same, reducing number of feeds.
Piglets	A dessertspoon of cream in a teacup of milk. Two to four ounces at six feeds per day. Or 2 dessertspoons Glucodin instead of cream.	Whole milk with a tablespoon of cream per pint to appetite at four feeds. Trough feed at 3 weeks. Replace Glucodin with brown sugar.

Notes on Table.

(1) Colostrum from a newly kidded goat may be given to the newborn calf and the new-born lamb, but not to any other oew-born. One feed is sufficient.

(2) All feeds must be fed at blood heat and at regular iotervals. But the interval before the last feed at night may be longer than the others. Feeding-bottles must be sterilized after each feed.

(3) *Calves.* Give a dessertspoon of olive oil or castor oil in the first feed if the calf cannot receive colostrum.

(4) *Lambs.* Give a teaspoon of olive or castor oil in first feed if the lamb cannot obtain colostrum. Feed milk in a polythene baby's bottle fitted with lamb teat, or in a nylon 'Evenflo' bottle.

(5) *Foals.* Give a first feed of a dessertspoonful of castor oil io *whole* milk if the foal cannot receive colostrum. Feed from a wine bottle fitted with calf teat.

Pups. Add two drops of cod-liver oil to the first two feeds. Feed with a glass dropper or, in emergency, with a fountain pen. Add 'Sister Laura's Food' for weaklings and miniatures.

Kittens. Feed with a glass dropper or fountain pen.

Piglets. Add a teaspoon of cod-liver oil to first two feeds if the piglet has not had colostrum. Feed with a polythene baby's bottle and baby's or soft lamb teat.

The details given above should suffice to tide the farmer and his

orphan over a crisis. But for the goat-keeper who wishes to develop the commercial possibilities of 'foster-milk' other considerations are of importance.

The best place for a goats' milk orphanage is on an unspecialized small-holding. In any reasonably densely populated farming district there is a reliable if seasonal supply of orphan lambs, orphan piglets and piglets surplus to the milking capacity of the sow, with an occasional orphan foal to add interest. A word to the veterinary surgeon and a little market-day advertising will canalize the supply in the required direction. Orphan lambs can be reared on cows' milk, though they seldom do nearly as well as they do on goats' milk. Consequently, orphan lambs command a fair price. Piglets reared on cows' milk from birth never pay their way and usually die. So orphan and surplus piglets are cheap and provide the staple throughput of the goats' milk orphanage.

The first rule of the orphanage should be: fresh orphans only. There is little hope of making a profit out of any new-born creature that has already had its digestive system and vitality undermined by a diet of cows' milk or cows' milk and water, or by simple starvation. This is especially true of piglets, who are not worth having unless they are fresh from the sow.

Piglets will take to the bottle easily. The weaker of them may benefit from the addition of a little glucose to the feeding recipe given in Table 4, but this should not be continued for more than two or three days. The piglet's main need during the early stages is for warmth. For a regular orphanage business an electric- or paraffin-operated infra-red heater is worth while. For casual business a straw bed of good depth, with a few well-wrapped hot-water bottles under the surface, will suffice.

Frequent feeding of the piglets during the first three weeks is essential. Six feeds at, say, 7 a.m., 10, 1, 4, 7 and 10.30 p.m., will suffice without greatly disrupting the peace of the farmer. After three weeks four feeds a day will be sufficient, and the milk can be fed in a trough, with a little taste of meal and some milk-soaked bread added as soon as they have become accustomed to the change. The meal ration is increased as the piglets grow, and by five weeks old they will be able to maintain progress if the whole milk is replaced by skim.

From a few days old the piglets should have room for exercise; if weather and circumstances permit, they will do best with a grass run; otherwise they must have some turfs or soil to supply the iron they

need. If there is a good supply of piglets the goat-keeper is best advised to sell at eight weeks old, when the piglets will weigh about 40 lb. Sold at this stage they will return a price of 5s. to 6s. a gallon for the milk that has been fed to them, as well as the price of the meal, etc., they have consumed. If kept any longer the return per gallon will drop to about 2s., and a cream market would have to be found to make the enterprise profitable.

These comments are not intended to describe methods of pig-rearing—for which the writer is not qualified—but to clarify the main points of contact between goat-keeping and piglet rearing.

Orphan lambs should always be reared on the bottle and never suckled on the goat. This is in the best interests of both parties. Ewes have smaller and tougher teats than goats and a lamb is likely to break the skin on the goat's teat, with its teeth, and give rise to black garget infection. The goat's grazing habits are very different from those of the sheep and a goat suckling a lamb will lead it to pastures unsuitable to the lamb and teach grazing habits inimical to the lamb's digestion.

Calves will not feature in the goat orphanage; there is plenty of cows' milk. But calf-rearing can provide a basis for profitable goat-keeping. We are not concerned here with the farmer who keeps goats and uses their milk to rear his replacement heifers, while drawing the subsidized price for the cows' milk the calves would otherwise have consumed. But a goat-keeper may specialize in calf-rearing.

The goat-keeper may reasonably expect to rear a slightly better calf than anyone else for two good reasons: the high digestibility of goats' milk will minimize set-backs from digestive troubles and will practically exclude the normal liability to white scour; the fact that goats and calves share but few internal parasites will afford both parties a measure of protection when sharing a pasture—the calf will eat the larvae of the worms that infest goats and the goats will eat the larvae of the worms that infest calves, with no ill consequence to either.

Stock-rearing of this kind is one of the least profitable forms of farming in these days. If calf-rearing is to be really attractive to the goat-keeper he must be able to rear a calf which cannot be matched by any other method of rearing, and command the premium his supremacy deserves. There is only one way in which this can be done: for a goat-keeper with a herd of Anglo-Nubians or Anglo-Nubian crosses (that is, a herd producing milk with an average butter-fat of over 5 per cent), to rear pedigree heifers of a breed giving low butter-

fat milk. A Friesian heifer reared on Anglo-Nubian goat-milk is a better reared beast than any Friesian heifer has a natural right to be. If you put a Friesian calf on to Jersey cows' milk, it will get the butter-fat, but it will also get indigestion. Only the goat can do the job better than Nature.

This is not the job for the novice, nor even for the specialist goat-keeper without other experience. The calves worth rearing are worth three figures at birth. But here is an opportunity for a first-class all-round stockman with a good knowledge of goats, and a special knowledge of bringing out cattle, to do an independent job dear to his heart and good for his pocket.

Calves will literally, and properly, go down on their knees for a drink of goats' milk, and may be suckled on a goat with adequate teats. The system has been practised without mishap on a small scale: whether the saving of labour and the additional protection from scour provided by direct suckling is worth the risk of injury to the goat's udder, only time and experience can tell.

How the stars of Capricorn will twinkle when the champion dairy cow is reared on goats' milk!

Chapter 14

GOATS' MEAT AND KID

Señor Egaña, the author of the Spanish textbook on goat-keeping, is also a director of Madrid's central meat market, which has as big a through-put of goats' meat as any in the world. 'The goat', states Señor Egaña, 'is a bad butchers' beast.'

Unlike the British goat-keeper, Señor Egaña does not leave the matter there, but proceeds to show how the best is made of a bad job. It appears unlikely that the goat industry can afford to adopt a defeatist attitude to any potential source of income. It is not improbable that economic stringencies, or worse, may again produce the national meat shortage which, in 1950, obliged the butchers in the larger towns and seaports to offer as high a price for goat meat as the Ministry of Food was paying for prime lamb. Even these prices failed to tempt the majority of goat-keepers out of their reluctance to regard goats' meat as edible.

Goats' meat can be classified into four grades: First, kid, which is the meat from animals between a few weeks and nine months of age, and will be considered separately. Second, goat wedder mutton, which is the produce of castrated males of from nine months to eighteen months or more. Third, billy meat, from uncastrated males of six months upwards, for which there is a strong but restricted demand in seaports visited by Lascar seamen. This trade is often in live billies. Fourth, old goat meat from worn-out milkers.

Goat wedder mutton is in the same class as the better types of ewe mutton and venison. It will include the meat of sterile goatlings. As a cooking proposition it offers the same type of problem as venison—namely, lack of fat. It can be treated in either of two ways: it may be 'larded', by running narrow strips of pork or bacon fat through the flesh with a larding needle, and then used in any standard mutton recipe; or it may be 'marinated', by letting the joint lie in, and basting it with a mixture of olive oil and vinegar with some herbs or spices, for three or four days, when it may be treated as prime venison.

From an economic point of view, it can only pay to produce goat wedder mutton on scrub-covered cliffs where no other animal but the goat can graze, and where the goat can make a living all year round. An annual gathering to castrate the kids is the only essential expense of time and labour, and is practicable in most wild or semi-wild flocks. A ·22 Hornet rifle represents the most convenient method of bringing the mutton to market. But over-feeders of goatlings may be able to recoup part of their losses on sterile fatlings in this way. At present (1966) meat prices, 1s. 9d. to 2s. per lb. dressed carcase weight, would be a fair wholesale price—which would become 3s. 6d. to 4s. per lb. on the butcher's slab.

The price of billy meat in the Lascar trade will be around 1s. per lb. liveweight; the majority of male goats would serve the industry as well in this way as any other.

The nature of old goat meat depends almost entirely on the condition of the animal when killed. If in reasonably good condition, the meat can be marinated and will then be suitable to replace stewing mutton in any recipe; it will be better flavoured but slightly tougher. Poorer animals will furnish meat for mincing and dog food. The local Master of Foxhounds in any district will be interested in the worst specimens. So will zoos. The price to be expected is in the neighbourhood of 6d. to 1s. dressed carcase weight (which is about 40 per cent of liveweight). Knackers are less generous.

Kid meat can be a prime meat, and is an entirely different proposition from any other kind of goat meat. The male kids arrive whether we want them or not and for four days at least the goat produces milk which is of little use for anything except kid-rearing. So we have a 10 lb. kid free gratis.

From a culinary point of view, kid is rather more versatile and almost as good as lamb; for the modern taste for lean meat kid meat may well prove superior. The flavour of meat depends to a great degree on the condition of the animal from which it is derived; it is not possible to bring lambs to the condition in which their meat develops its optimum of flavour without at the same time introducing more fat into the meat than the modern housewife cares to see. But perfectly conditioned kid still presents a lean chop.

The objection to producing kid meat is a purely economic one, which arises, not from the inferiority of the meat, but from the fact that the goat in this country does not produce a wool crop. A hill ewe produces a wedder lamb for marketing on the average once every two or three years, and a wool crop worth 15s. to £1 a year—that is, an

annual income of about 30s. to 40s. for lamb and 15s. to 20s. for wool. On a comparable standard of living the goat could produce only 30s. to 40s. worth of kid.

On a higher standard of living sheep will produce up to £7 worth of lamb and about the same (15s. worth) of wool. On a similarly high standard the goat would produce £3 worth of kid meat and about 60 gallons of surplus milk. As this milk can, at the worst, be cashed into pig meat at 2s. a gallon, there is no incentive to turn it into kid meat.

The price of meat in Britain in the year 1965 is a highly artificial arrangement. There is a preferential subsidy on the production of beef as against mutton, and a large subsidy on pig-meat production. In a more natural economy—and economies, like goats, tend to revert to Nature—it is probable that a working compromise between the value of kid meat and the value of goats' milk for other purposes could be struck along the lines followed in most north European countries.

The main bulk of the surplus kid crop is marketed at four to six weeks old; a smaller proportion, from more isolated districts where alternative uses for goats' milk are more difficult to find, are marketed at about three months, while a significant minority are sold at the end of the summer, when six months old.

The introduction of such an arrangement into this country would be dependent on a demand for kids' meat as such. But, in fact, the reluctance to regard kids' meat as a normal and proper food emanates more from the goat-keeper than from the butcher and caterer. Whatever the housewife may imagine she thinks about kid meat the catering industry has already provided itself with sufficient evidence to show that the housewife and her husband are very glad to eat kid meat when they are dining out. The catering industry can easily absorb all the kid meat that we are likely to produce at competitive prices. In many immigrant communities, kid is worth more than lamb.

In the meantime it is worth pointing out that the price of meat in the butcher's shop is today approximately twice the price that the farmer receives per lb. dressed carcase weight. So kid meat is worth twice as much if you eat it at home as if you sell it to the butcher.

Kid-meat production brings one new consideration into goat-keeping practice—the necessity to castrate the male kids at birth. The effect of castration on the growth rate of male kids is far greater than is the case with ram lambs and bull calves. The male kid may be

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Kid-meat production brings one new consideration into goatkeeping practice—the necessity to castrate the male kids at birth. The effect of castration on the growth rate of male kids is far greater than is the case with ram lambs and bull calves. The male kid may be

sexually mature at three months, and, at that age, the effect of castration at birth may result in doubling the efficiency with which the kid converts milk into meat. The meat is also of better quality.

By far the simplest and safest method of castration is by the 'Elastrator', a device for applying a specially designed rubber band which cuts off the supply of blood to the scrotum. It should be used within a day or two of birth if possible, and the sooner the better.

From a culinary point of view, kid meat is of three types: Month-old kid, which is a white and rather glutinous meat, is like veal, or chicken in the *poussin* stage. It can be used in most veal and *poussin* recipes, but is best in the more highly flavoured ones. Three- to four-month kid can be treated as spring lamb, which is a singularly happy thought in days when there are very few spring lambs to be treated; the better restaurants and hotels can be very grateful for this type of meat. Six-month to nine-month kid can be larded and treated like lamb; but it is at its best when marinated, for then it becomes as well flavoured as prime venison and as tender as prime lamb and can be used in recipes designed for either meat.

Some recommended recipes are given below.

Roast Kid (Central France)

A leg of kid of three to four months old, weighing 3 to 4 lb., is pierced with the point of a carving knife in eight to twelve places where the flesh is thickest. Into half of the gashes place a piece of peeled garlic the size of a split pea; in the rest of the gashes force ¼-in. strips of bacon fat or salt pork.

Place the kid in a roasting-tin with ½ pint water and a teaspoonful of salt; break 1 oz. of butter into small pieces and dot them over the top of the joint.

Roast in the oven at 340° F., allowing twenty minutes per lb.

Remove the joint into a heated dish and keep hot. Scrape the bottom of the roasting-tin, add a little water if necessary; strain and serve this gravy with the meat. Garnish with watercress.

Roast Kid (French Alps)

Chop a 1-in.-long sprig of tansy or thyme, a handful of parsley and two cloves of garlic; crush a teaspoonful of dill or caraway seeds; mix the chopped and crushed herbs with 2 tablespoonfuls of wine vinegar, a teaspoonful of salt and a teacupful of olive oil.

Lay a fresh leg of kid of six to nine months old on a dish; pour the

above mixture over it; baste it with this sauce frequently and turn it daily for three to four days, keeping it in a cool airy place.

Pour a teacupful of the sauce into a roasting-pan. Place tbe joint in tbe pan and roast in the oven at 300° F., allowing thirty to thirty-two minutes per lh.

Ten mioutes hefore the meat is done, melt 2 oz. of butter in a saucepan, add a small clove of garlic well chopped; let it simmer five minutes; stir in 1 tablespoonful of flour; cook and stir till the flour is golden hrown; add ½ pint of stock or bot water and stir vigorously till the sauce thickeos; withdraw from the heat, and add 1 tablespoonful wioe vioegar, 1 teaspoonful dark honey, 1 tahlespoonful coocentrated tomato *purée*—or 2 tahlespoonfuls fresb tomato *purée*—aod continue heating till the sauce starts to boil.

Serve this sauce with the roast kid; do not serve the gravy from the roasting-disb.

This is kid at its best.

Grilled Shoulder of Kid (an old Highland recipe)

Detach the shank from tbe blade of a sboulder of kid of three to six montbs old—so that the joint is shaped like an axe-head. Lay aside the sbank. Sprinkle tbe joint with salt and ruh it over liberally with butter.

Place on a grilling-rack 3 to 4 in. under the grill, wbicb sbould be moderately hot; turn the joint frequently and baste occasiooally; test for readioess by pricking the thicker portions with a fine needle; the exudation should be pale piok.

Serve with rowan or red currant jelly.

Pekin Kid (adapted from a Chinese recipe: *suitable for* meat from any age of kid)

Cut the kid meat into small pieces, dip in a thin flour, water aod salt batter, and deep fry till golden hrown. Lay aside in a warm place, to drain.

Melt 2 oz. of hutter in a large saucepan, add ½ lh. of carrots cut in fine *strips*, and a dozen sticks of celery or seakale beet cut in short lengths; cover and cook slowly, tossing and stirring occasionally. Add water only if and when necessary. Cook twenty minutes.

In another saucepan heat 3 tablespoonfuls of olive oil until smokiog hot, stir in 2 tablespoonfuls of flour and cook till golden brown; add ¾ *pint* of stock and stir vigorously until the sauce thickens. Withdraw

from the heat and stir in 1 teaspoonful of golden syrup, 1 teaspoonful of French mustard, 1 tablespoonful of mango chutney and a little pepper. Pour the sauce over the vegetables, add ½ lb. mushrooms and half a teacupful of chopped chives and then the fried meat which was laid aside. Cook for five to ten minutes. Add 1 lb. of finely shredded cabbage, cover and keep barely simmering for twenty minutes more.

Serve with rice.

Kid and Green Peas (Normandy)

From a kid about one month old cut small pieces of meat, salt and flour them and brown them in butter in a large saucepan. Add 1 pint water per lb. of meat and stir till blended. Then add 4 spring onions, one 6-in. sprig of parsley, and 1 lb. of fresh green peas per lb. of meat. Simmer gently for one hour.

(If tinned or frozen peas are used, they should be added only fifteen minutes before serving.)

Kid in Cream (Sweden)

From a kid of about one month old cut slices of meat or small joints for serving. Sprinkle all over with salt and pepper and dredge very lightly with flour. Place in a thick saucepan with a half cup of thick cream per lb. of meat and bone. Cook until the meat is browned, turning frequently and adding more cream as necessary. Cover and cook gently until the meat is tender.

Remove the meat into a heated dish and keep hot. Add sufficient flour to the fat remaining in the pan to make a smooth cream. Cook for three minutes, then add equal parts cream and kid stock (or chicken stock), allowing half cup of each for every 3 tablespoonfuls of flour added. Stir till the sauce boils. Add chopped parsley and pour over the meat.

Goat Ham (a traditional Highland recipe)

The hind leg of a twelve- to eighteen-month old castrate (or sterile goatling) is trimmed to shape and rubbed with the following mixture: 1 oz. saltpetre, 4 oz. brown sugar, 1 lb. preserving salt, 1 oz. white pepper, ½ oz. of cloves, 1 grated nutmeg, and ½ oz. coriander seeds. Rub the mixture into every crease and crevice in the flesh and stuff some up the hole in the shank. Lay the ham in a trough and cover it carefully to exclude dust and flies; baste it with the brine and turn

28. Outside the Malpas goat-house Malpas Mimoya and Malpas Moya display the utilitarian charms of the Anglo-Nubian breed. Owner and breeder, Mr. Egerton

29. She is typical of the dairy goats of Spain, and might have been a prize winner in the class for Granada goats at the Concoursa Nacional at Madrid. But she was born in Devon, is entitled R3 Bellyie, has given over 3,500 lb. of milk in 365 days and is a good example of the *potentialities for new breed formation of the British* Section of the BGS Herd Book

30 *and* 31. Goat Stock improvement in Israel The upper picture shows a native goat of Mamber type wearing the short twisted horn of *capra prisca*. In the lower picture is a cross between the native goat and an imported Saanen male. She will get a lot of dust and insects in her ears but will give more milk. If we breed for export we must consider the needs of our customers

it every day for a fortnight. Then take it out and press it on a draining-hoard for a day.

Remove one end from, and wash out, a treacle barrel or a wooden cask. Make a heap of small birch branches and/or juniper branches and/or oak sawdust in the hottom of the treacle harrel, and bury in the heap a thick har or lump of red-hot iron; bang the ham from tbe top of the barrel and cover to conserve the smoke; punch one or two small holes in the hottom of the barrel to keep the *smouldering* going. Smoke the ham in tbis way for as near a fortnight as may he. Then hang it in the kitchen till required. It can he dried by banging in the kitcben if necessary, hut the flavour is much improved by smoking, especially if juniper is used.

Chapter 15

LEATHER AND MOHAIR

Goats' skin provides the raw material for many of the top-quality products of the leather industry. Morocco leather is derived from the long-haired goats of cooler climates. Glacé kid and suède kid shoe leathers are derived from nine- to eighteen-month old castrates and adult goats of warmer regions. True kid skins, from animals of one to six months old, supply a rather limited market for high-class glove-making.

A kid skin when dried will weigh up to 14 oz., a goat's skin from 1½ to 2 lb., and the skin of an adult male from 3 to 5 lb. The potential output from Britain's twenty to thirty thousand goats would appear to be considerable at present-day leather prices.

But, in fact, 90 per cent of the price of leather products is accounted for by purchase tax and the costs and profits of processing and retailing. Home-produced goatskin is essentially of poor quality and, in any country, the marketing of raw goatskins is dependent on the existence of a substantial market for goats' meat. Goatskins, like other skins, are no more than by-products of the slaughter-house.

The best skins come from goats on a low standard of nutrition; in practice they come mainly from goats which are kept primarily for meat production in areas too poor to sustain dairy enterprise. The skin of the well-fed goat is too heavily impregnated with fat to dress satisfactorily; the texture of the skin of housed goats is weakened by abnormal activity of the sweat glands. The best goatskin in Britain is worn by the scattered flocks of feral goats, and this will make up into morocco leather of fair quality.

Nevertheless, goat-keeping is so often a commendable gesture of independence that many goat-keepers will be interested in using this goat product. Though it may prove impossible to produce a first-class article, we can produce, from our own goatskin, sound and serviceable leather goods for our own use at about one-fifth of the cost of buying comparable articles.

The quality of a skin is much influenced by the time of year at which the goat is killed. During the summer the skin of the goat is pinkish and full of small blood-vessels which are conveying into and storing in the skin the nutrients required to produce the denser winter coat. Leather made from such skin is weak and open in texture and difficult to cure satisfactorily because of the presence of perishable nutrients which give the leather a muddy appearance. When the goat is in full winter coat, the skin is white and the skin nutrients have been transferred to the hair. At this stage both leather and hair are at their best.

Skinning the goat should always be done when the body is still warm; the ligaments attaching the skin to the body of the goat are remarkably strong; if left until cold it is extremely difficult to remove the skin cleanly. With a sharp knife make a single clean light cut from a central point between the two teats to the skin above the breast bone. Do not cut more deeply than is necessary to penetrate the outer skin. From the same point make a cut to the skin above the first joint of the hind legs. Loosen the skin from the belly and thighs, using the fingers and a small wooden paddle, like a flat wooden spoon, but not a knife.* Then carry on the leg cuts to a point just above the hoof; strip off the leg skin and cut it clear of the hoof. Loosen the skin around the anus and vulva and cut around these openings. Cut a slit along the centre underside of the tail and peel the tail skin. Now loosen and peel the skin from the back and flanks, using the paddle to loosen the skin right up to the front of the chest. Continue the first belly cut up to the throat and work the skin carefully free of the keel of the chest, where the attachment is very close. Cut a slit up to the first joints of the front legs and strip them in the same way as the hind legs. Cut right round the head just behind the jaw-bone and ears and peel the remaining skin from the neck. It is quite easy to skin the head of a kid, when the whole skin can be stuffed as a toy; but it is seldom worth skinning a goat's head.

The following curing recipes both come from Canada, a country in which there is a richer contemporary knowledge of do-it-yourself methods than there is in ours.

To remove the hair from a goatskin, make a solution of 4 quarts slaked lime, and 5 gallons of soft water; then stir in 9 pints of hardwood ashes. Stir the mixture and soak the skin in it for three hours, then hang it on the side of the tub for a few minutes to drain off. Do

* The butcher uses a sharp knife and does the job more quickly; but for skin and skinner this is a safer method.

this four times the first day, three times the next day, and once a day thereafter, until the hair starts on the thickest part; then rinse off in clean water and scrape off the hair.

To tan goatskins, with or without the hair on, first carefully scrape off all flesh and fat adhering to the skin, with a very blunt knife. Then soak the skin for two to six hours, according to thickness, in the following mixture: 4 gallons cold soft water, ½ oz. borax, ½ pint common salt, and 1 oz. sulphuric acid—the ingredients being stirred in in that order. After being soaked in this preparatory mixture the skins will be ready for the tanning mixture which is as follows: 2 gallons cold soft water, 4 oz. pulverized oxalic acid, 2 pints of salt. Leave the skins in the tanning mixture until there are no dense spots to be seen; this will be about forty-eight hours for a kid skin and longer for thicker skins. When tanned, remove the skins from the mixture, wring them dry, and hang them in the shade or under cover in an airy place; pull and work them as they dry, so that they dry soft.

To store skins for curing, prepare a concentrated brine solution by adding salt to boiling water until the water will take up no more; cool and store the brine solution in airtight containers. Dip the skin to be stored in the brine solution, lay it hair-side down on a wooden floor which has been sprinkled with salt; sprinkle the flesh-side of the skin with salt; lay subsequent skins, similarly treated, on top of the first, in piles of up to twenty-five skins. When no further skins are likely to be forthcoming for a considerable time, bundle the salted skins by rolling up the pile; tie with string, wrap in thick brown paper to exclude flies and moths, and store for up to four months. Before curing, soak and rinse the skins thoroughly.

To cut a tanned skin to shape, lay it, hair-side down, on a wooden table. Mark out with a pencil and cut with a razor blade or special leather knife.

Goat hair has a number of commercial uses. The coarse long hair is in some countries used for weaving into tent cloth and for making the basis of carpets and rugs. Mohair, the produce of the Angora goat which is widely farmed in U.S.A., South Africa, and, to a lesser extent, in countries of the eastern Mediterranean, is an important textile. Cashmere wool is the fluffy undercoat of goats living in the high altitudes of the Himalayas. The annual crop is hand-combed from the goat, the process taking one or two weeks to complete.

The Cashmere goat will live in Britain, but the quality of its fleece

deteriorates in a mild climate. There is no economic prospect for it, but as a source of mildly useful interest, Cashmere goats might well replace the rather fatuous experiments in reindeer husbandry proceeding in the Cairngorm National Park.

Angora goats will also live in Britain, but their fleece deteriorates in areas where the average annual rainfall exceeds 20 in. A flock kept by the late Duke of Wellington in Hampshire produced mohair of a quality comparable to the second and third grades of imported mohair, and superior to that produced in the eastern Mediterranean.

There probably exist a few scattered areas along the east coast of Britain which could be exploited more efficiently by Angora goats than by sheep. As a farming proposition the Angora is to all intents and purposes a sheep that will live on scrub and weeds. The fleece is heavier and worth more per pound than that of the Blackface sheep and is sheared in the same way. The flesh is superior to all other goat meat, and at least as acceptable as prime mutton to the fat-abhorrent housewife. The milk yield has no economic importance.

As far as the hair of our dairy goats is concerned, short hair is of no interest, but there exists a very small but generous-hearted demand for long goat hair, with top prices for white. This is used for kilt-sporran making, in which there is a minute export trade, and for research purposes. The demand is so small that it is most economically met from home supplies.

Goat hair, and fabrics made therefrom, have been shown to provide effective screening from radio-active fall-out.

Chapter 16

CROPPING FOR GOATS

This chapter is intended to help the domestic goat-keeper, who wishes to grow a substantial proportion of the food required by two or three milkers. If proper use is to be made of the manual labour involved, and of the restricted cropping space normally available, crop production on such a small scale calls for exceptional accuracy in estimating and applying the quantities of seed and manure needed, and in allocating space to appropriate crops.

The goat cropping ground under such circumstances is liable to be interchangeable with the kitchen garden; so the soil must be treated in a way consistent with high-quality market garden production, and not like ordinary farmland. A high humus content must be maintained and the fertilizers used must leave no toxic residues. The need to grow field crops by garden methods, in quantities nicely adjusted to the appetite of two or three goats, is not catered for in either agricultural or horticultural textbooks. So a few guide lines are offered below.

A goat giving up to 350 gallons a year, which is as good a goat as most of us can hope to own, needs the cropping capacity of rather more than half an acre to supply all her food. A goatling needs about one-third of an acre, a kid needs about a quarter of an acre in its first year.

In allocating the cropping ground to different crops, and matching the size of the various plots to the goats' needs, it is convenient to use as our unit of reference the 'pole' or 'rod' of 30½ square yards. It is easily visualized as the standard 3 yards by 10 yards vegetable garden bed. One hundred and sixty poles go to the acre; 1 ton per acre is equivalent to 1 stone (14 lb.) per pole, which eases the translation of field crop recipes. In terms of poles, a good milker needs about 95, a goatling 54, and a kid 37—that is to grow all its food, concentrates, hay, the lot.

To calculate the goats' needs in terms of actual crops, winter and

summer feeding must be considered separately. In winter, a 180-lb. goat in milk will need about 5 lb. of hay a day, to maintain health aod hutter-fats, her standard 2 lb. of concentrates for maintenance, aod as much kale and roots as her milk yield justifies. In terms of starch equivalent (s.e.) that is 1½ lb. s.e. from hay, 1¼ lb. s.e. from concentrates and 2¼ lb. s.e. from kale or roots, for a goat giviog a gallon of milk a day. Winter is shorter in the south than in the north, but assuming a six-month northern winter, the goat is goiog to need a total of 270 lb. s.e. from hay, 225 lb. from concentrate and 405 lb. from kale, etc.

In summer, we may allow the same six months concentrate requirement of 225 lb. s.e.; the rest of the ratioo, say 675 lb. s.e., will be wanted in the form of fresh green fodder.

The productivity of land, in terms of starch equivalent, varies somewhat with inherent fertility, and the suitability of crop to soil and climate; but on garden-size plots worked by garden methods we can assume a high level of fertility; provided we choose crops to suit the district, we can make some useful generalizations. Hay and grain crops yield about 14 lb. starch equivalent per pole; green crops, sueh as grass, cabbage, kale and lucerne, yield about 20 lb. stareh equivalent per pole, aod enough protein to balance the stareh equivalent for milk produetion. The popular root crops yield about the same amount of starch equivaleot as the green erops, but with very little protein. We can summarize the position as follows:

		per day	*per six-month*	*in cropping ground*
Needed for a milker:				
(winter)	from hay	1½ lb. s.e.	270 lb. s.e.	20 poles
	from corn	1¼ lb. s.e.	225 lb. s.e.	16 poles
	from kale etc.	2¼ lb. s.e.	405 lb. s.e.	20 poles
(summer)	from corn	1¼ lb. s.e.	225 lb. s.e.	16 poles
	from green crops	3¾ lb. s.e.	675 lb. s.e.	34 poles
Needed for a Kid:				
(1st summer)	green crops	1½ lb. s.e.	270 lb. s.e.	13 poles
(winter)	from hay	1 lb. s.e.	180 lb. s.e.	13 poles
	from corn	½ lb. s.e.	90 lb. s.e.	6 poles
	from kale etc.	½ lb. s.e.	90 lb. s.e.	5 poles
Needed for a Goatling:				
(winter)	from hay	1½ lb. s.e.	270 lb. s.e.	20 poles
	from corn	½ lb. s.e.	90 lb. s.e.	6 poles
	from kale etc.	½ lb. s.e.	90 lb. s.e.	5 poles
(summer)	from green crops	2½ lb. s.e.	450 lb. s.e.	23 poles

Of course, neither milking goats, kids nor goatlings maintain this conveniently level appetite throughout the year. But when planning the cropping, it is impossible to forecast food needs with day-to-day

accuracy months ahead. The method suggested above maintains a flexible link between supply and demand and includes a necessary margin for error and for partial crop failures. Many domestic goat-keepers may prefer to buy in their concentrates, or their hay, or both; using the above method it is easy to adjust the cropping plan accordingly.

There is no great difficulty in growing the goats' corn and concentrates in small garden-scale plots, but special considerations are involved. In the British climate the choice of high-protein concentrate crops is limited, practically speaking, to beans, peas, and linseed. Goats are not always very keen on beans, which have a slightly constipating effect. Peas are tricky in a wet season in a wet district. Linseed too prefers a sunny climate and suffers much damage from wet harvest weather; even in the best of seasons, it is not a heavy cropper, yielding but 8 lb. of starch equivalent per pole, of a valuable, but not very convenient, food. In many districts it may prove advisable to grow the concentrate ration in the form of oats or barley, and to rely on the fresh green foods to provide the protein needed to balance the diet. On the other hand if a balanced concentrate mixture is bought in, it may be preferable not to stake too much on the kale crop, which is the key to winter protein; kale too often falls victim to accidents of weather and the persistence of wood pigeons. Fodder beet and potatoes are much more reliable crops for winter feeding. In summer, a succession of mashlum, maize and fodder radish can replace lucerne, with a gain in variety of diet and a saving of cropping space, provided the concentrate ration is a bought in, balanced mixture.

If grain crops are to be grown to provide the concentrate ration, their straw will relieve the demand for hay—if their straw is edible. No allowance is made for this uncertain factor in the table above. By harvesting the cereal crop before it is quite ripe, and feeding it 'in the sheaf', the hay and concentrate ration may be combined—which has advantages for kids and goatlings, and disadvantages for heavy milkers.

Are the goats to be put out to graze during the summer? It will save a lot of labour if they can thus be made to do their own food gathering. But it is very difficult for a few goats to make full use of a small area of ground if they are put out to graze on it. Five goats, put out to graze the 1 acre of pasture which is the minimum needed to provide their summer keep, concentrates apart, would be faced in July with a patchy paddock of seeded and exhausted grasses, carrying a burden of parasitic worm larvae which would explode into big trouble with each spell of warm, wet weather. This is the most un-

economic way to use pasture. Divide the acre into four and rotate the goats around these four little paddocks, allowing about a week in each, and the results would be better, but much grass would be fouled with droppings and wasted. Strip grazing, with the goats on running tethers (p. 116) or controlled by electric fencing, makes good use of pasture, but the goats may become so fretful with the close restraint, especially when discomfited by hot sun, flies, wind or rain, that they fail to eat their fill, and fail to give of their best. With five goats to feed, the balance of advantage may lie with rotational or strip grazing. With two or three goats and similarly restricted acreage, it is often best to cut and carry all they require—in which case, grass, though indispensable at some seasons, is not always and everywhere the ideal crop.

The following table shows the productivity of the major goat crops.

Crop	*Weight of Crop per pole lb.*	*Starch Equivalent per pole lb.*	*Notes*
Hay	30–40	10–14	
Oats (grain only)	18	11	
(straw only)	28	5½	
Barley (grain only)	21	14	
(straw only)	21	5½	Seldom eaten
Beans (seed only)	28	14	Protein rich
(straw only)	31	5½	
Peas (seed only)	28	14	Protein rich
(straw only)	30	5	Edible
Linseed	7	8	Protein rich
Lucerne (hay)	40	11	Protein rich
(fresh cut)	210	21	Protein rich
Cabbage (drumhead)	240	14	Protein rich
(openheaded)	210	16	Protein rich
Kale (marrowstem) or (Thousand headed)	210	19	Protein rich
Maize (cut when cobs are milky)	180	17	
Comfrey	300	15	Protein rich and very early
Buckwheat	100	8	Very tasty, for poor ground
Chicory	200	10	Very early
'Herbal Lea' (cut)	180	24	Cut when under one foot high
(strip grazed)	*150*	*21*	
Italian Ryegrass (cut)	200	22	
Nettle hay	35	14	High protein
Fodder radish	200	16	
Rape	180	12	
Fodder beet	150	19	
Potatoes	110	20	Feed baked or boiled
Mangolds	300	18	
Swedes	240	17	
Carrots	130	12	

For such of these crops as are normally grown in the garden, gardening books will provide a wealth of information on manuring and methods of cultivation; for some of the other crops the following notes may be useful.

Oats yield better than barley in wet, cold, districts and provide a more balanced feed than barley anywhere. In wet, late districts a soft-strawed oat, such as Bell or Castleton, is a good proposition, especially if cut on the green side and fed in the sheaf (i.e. unthreshed). In drier districts a grain oat, with a relatively hard, short, straw is generally preferred; Sun II is a good dual purpose type.

Manuring. One barrowload of compost (not dung) per pole, 5 lb. Hoof and Horn meal, and 5 lb. Bone meal, worked into the seed bed.

Sow 12 to 14 oz. per pole, in March to April, in seed bed with moderate tilth. If cutting green, cut when the grain exudes milk when pressed; if cutting for grain, cut when the last tinge of green is disappearing from the heads and leave in stooks or on tripods to dry for a fortnight.

Barley. *Manuring.* A barrowload of goat dung, 7 lb. Hoof and Horn meal, and 4 lb. Bone meal, worked into the seed bed.

Sow from 12 to 20 oz. per pole, according to the coldness and wetness of the district and the lateness of the sowing, into a fine deep seed bed from early April onwards. Cut for hay or green fodder in the flowering stage; cut for grain when dead ripe.

Beans. Use field beans for a seed crop. (Though runner beans are a productive green crop.)

Manuring. Two barrowloads of goat dung, and 5 lb. of bone meal per pole into the drill in late autumn, or spread, for a broadcast crop, in spring.

Sow in February at 3-in. intervals, in the dunged drills 20 to 24 in. apart, allowing 1½ lb. of seed per pole. Cut when the middle pods are just ripe and dry on tripods. If to be grown mixed with oats, as 'mashlum', broadcast 14 oz. beans per pole into the manured seed bed in February, and 12 oz. of a soft-strawed oat three weeks later. Cut when the beans are ready. Dry on tripods, set over paper sacks to save the seed.

Peas. *Varieties;* 'Marathon Maple', 'Minerva', Dutch Blue.

Manuring. Two barrowloads compost (not dung) with 7 lb. bone meal per pole.

Sow 3 oz. of peas with 12 oz. of oats, or 4 oz. of peas with 10 oz. of oats, in a deep moderate tilth in mid-March. Cut late August for

grain, at the oat milk stage for hay, or when the first pods are full for use as green fodder. Use tripods for drying.

Linseed. *Varieties;* 'Royal' for early districts; 'Redwing' or 'Dakota' for late districts.

Manuring. A light dressing of compost, or none at all if tbe previous crop was well manured.

Sow in April in a deep fine tilth, allowing 6 to 7 oz. per pole. Cut when tbe first bolls ripen, using a sharp blade and leaving a 6-in. stubble; the stem is very tough close to the ground. Linseed must be fed freshly ground, preferable mixed with bruised oats. The crop can be matured in the stook or on tripods; there is always some loss of seed and as young green linseed is a valuable and tasty feed, it is well to follow linseed with a green forage crop, such as peas and oats.

Lucerne. *Manuring.* Lucerne is a glutton for dung and compost throughout its long life. Two barrowloads of compost per pole in tbe autumn before sowing, one barrowload of dung worked into the seed bed in spring with 7 lb. of bone meal. A barrow of compost per pole per year.

Sow in April, ½ in. deep, in drills 10 in. apart, allowing 2 oz. of seed per pole. Soak the seed in bacterial culture obtainable from the seedsman, if tbe ground has not recently carried lucerne. Cut it before the flowers fade.

Comfrey. *Manuring.* Comfrey responds well to dressings of dung and compost and Hoof and Horn meal, once it is well establisbed, but in its first year in a fertile soil no manuring is required; on a hungry patch, a barrowload of compost per pole will be sufficient.

Planting. Plant the sets 3 ft. apart, both ways, in ground cleared of perennial weeds, in April. If the sets are not fresh and vigorous, keep tbem moist in a box of light compost in a closed frame until new growth is started, before planting tbem out.

Cut to within 3 in. of tbe crown of tbe plant, as soon as flowering stems appear, or at any time wben the plant exceeds 18 in. in beight. Do not let the plants flower, even if the leaves are not needed immediately for feeding; use unwanted cuts as a mulcb or as a compost accelerator.

Chicory. *Manuring.* Chicory is not a greedy feeder, but responds well to dressings of compost applied between the drills in early spring. Work one barrowload per pole of compost into tbe seed bed, with 5 lb. of Hoof and Horn meal, and 5 lb. of bone meal.

Sow in early May, ½ in. deep, in drills 1 ft. apart, allowing 2 oz. of seed per pole. The plants may be thinned to 9 in. apart, but this is not

and marrow-stemmed Kale are sown in April and crop from September to February; Asparagus Kale are sown in April and crops from March to May; Hungry Gap Kale is sown in July, and crops from March to May however hard the winter may be.

Buckwheat is sown in the second week of May, 12 oz. per pole, with no manure, for use as green fodder. It is very palatable. It may be sown, 6 oz. per pole, as a nurse crop for 'Herbal Lea'.

Nettles may be grown in bottomless buckets submerged to their rims in the soil, or in a bed edged with 1 ft. wide corrugated iron strips (e.g. Nissen hut link strips), set their width into the soil. Manure with dung and coal-fire ashes. Cut in the flowering stage.

Fodder Radish and Fodder Beet require much the same treatment as the related vegetable. Fodder Radish is a green fodder catch-crop, recently introduced as a big improvement on rape, being more productive, more nutritious, and free of the photo-sensitizing effects of rape. It usefully sown any time from early May to the end of August.

The harvesting of small-scale goat crops can be made easier if some form of drying rack is used to dry such crops as comfrey and chickory and lucerne and grass cut at the green fodder (under 1 ft. high) stage. A poultry field ark, with a slatted or wire-mesh floor, raised a foot off the ground to create a good under-draught, performs the function well. A purpose-made ark, using black corrugated iron sheets to absorb the maximum of sun heat, and providing generous ventilation at the ridge, would probably do the job better. Palatable silage, with less stench than the normal, can be made in plastic bags; fill the bags with the wilted green stuff, extract the air with suction pipe of a milking machine, and seal. This is an entirely practical and economic proceeding, but only if you are scrupulously careful in handling the plastic bags, so that they can be re-used. A vacuum cleaner would take a little longer than a milking machine, but if the material in the bag were not too coarse, the vacuum cleaner would be a good tool for silage making.

Chapter 17

FEEDING GOATS ON INDUSTRIAL WASTES

The organic waste products are many and troublesome. If you dump them into a river the bacterial content of the water rises steeply, so local authorities and conservancy boards normally forbid the practice. If you dump them on land they may putrefy and constitute a public nuisance; if you dump them in the sea sufficiently far from shore to avoid causing a nuisance, the expense is considerable; drying and burning may prove more expensive still. Consequently, industries producing organic wastes take great interest in the possibility of feeding them to livestock.

Most of the important organic wastes have been analysed and a great many of them have been subjected to feeding trials with cattle or pigs. Some, like sugar-beet pulp, are standard feeding stuffs; others, like pea haulm and pods from the canning industry, are a popular local cattle feed. Much miscellaneous waste of low fibre content finds its way to pig troughs.

There is nothing to prevent goat-keepers competing with cattle and pig-feeders in the purchase of suitable wastes, which are usually good value for the cost of collection. There is much to be said for the pig-feeder who uses industrial wastes, such as those of the catering industry and food manufacturers, to keep some goats to utilize the more fibrous wastes and help rear the piglets.

There remain a number of wastes which are not very suitable for feeding to cattle or pigs, but can be suitable goat food. These will include some very high-fibre materials like groundnut shells and skins, which can only maintain unproductive goats and are not of interest to goat-keepers; most of them are easily burnt, so the goat's ability to eat them is not of great interest to the industrialist.

There are other materials in which the fibre content is not inordinately high but includes a large proportion of lignin, and are unsuitable for cattle on that account. It has been suggested that goats

can digest lignin with greater efficiency than the cow; but the main evidenee in support of the contention appears to lie in the goat's foodoess for certain lignin-rich foods such as hrushwood aod tree bark. But the explanation may be simply that the goat's large food capacity leaves room for a certain amount of totally iodigestible lignio, while the cow, who must for health coosume a fair proportion of digestible fibre, has not room for aoy great quantity of indigestible fibre as well.

Whatever the cause, foods with a high lignio content, or with much indigestihle fibre of any type, are unsuitable for cattle even if they eontaio a good proportion of valuahle nutrients. But goats can make good use of this type of material. Bark from the chestnut fencing and basket-making industries might well provide costless hay equivalent for a suitably situated goat flock. But perhaps the most interesting materials in this class are the residues from fruit-juice extraction. Nature designs fruits to be eaten and the pips to be indigestible, so that the seed is sown in a rich compost of the dung of the fruit-eater. But within the tough shell of the pip are packed the cooceotrated nutrients the seedling oeeds to grow to the stage at which it can draw oo its surroundiogs. The cudding goat grinds fast aod small aod can crack the shell of many small seeds which pass through most bird and ruminant digestions uochaoged. The goat has room for the iodigestible fibre of a mass of shells which would embarrass the cow.

A small Italian industry is founded oo the goat's ability to extract a starch equivaleot of 60 aod sufficiency of proteio from tomato pips and skios. It is significant that the whole of the goat's requirements of digestible fibre have to be provided in the form of hay—the fibre of the tomato residue being apparcotly totally indigestible. Yields on this diet—tomato residue aad hay—are 3 to 4 lb. a day from 70-lb. goats: the equivalent of 180 gallons a year from a full-size goat. The goats are 'weaned' gradually on to the specialized diet over a period of eight to ten weeks.

Much of the tomato *purée* and sauce made up in this country is derived from imported pulp whose pips and skins have been eateo by other goats than ours. But waste of this type does exist in this country and there are large quantities of other wastes of similar type if not equivalent value. Of these the most promising is blackcurrant pomace, the pip and skin residue of the blackcurrant syrup makers. Goats eat it with benefit, but as the granular texture of the material limits their intake to about 1 lb. per head a day, of the dried material, it might well be suitable for incorporation in a compound goat cake.

A similar product, of less gritty texture, but lower protein content, is rose hip residue. This product has a high lime content and might be particularly valuable as a mineral balancer in a chemical-free compound cake for goats. Apple pomace from the pectin extractors has a good energy value but very little protein; dried, it finds a place in compound cakes, but the producers would welcome an outlet for the fresh material.

In seeking general and technical information for this book, 65 per cent of my inquiries of public and private concerns have received no, or dismissive, answers; inquiries regarding the use of industrial wastes for goats have scored a 100 per cent response. The field so opened is so obviously one for experiment and exploration that, for the purposes of this book, I must reluctantly leave it for more well-trodden ways of established practice.

But I leave the gate open behind me.

In Dr. Woodman's 'Rations for Livestock—Bulletin No. 48', published by Her Majesty's Stationery Office, interested goat-keepers will find a mine of potential goat foods among the list of analysed by-products. Personal inquiries of the producers of these materials will be kindly welcomed.

The industrialist will find among goat-keepers people willing to arrange a practical test of a potential goat food with greater alacrity and less expense than the National Agricultural Advisory Service may have led them to expect. The British Goat Society's prime aim is to disseminate information on goats and they will lend what assistance they can. Once a *prima facie* case for a new goat food is established, it should be possible to arrange a full-scale trial over a period of a year for a sum of £1,500 or less—a very small fraction of the annual waste disposal charges in many industries.

Among the less likely enterprises I have encountered in my researches in this field is the fattening of goats on skim milk in Kenya; the resultant goat mutton proved more profitable than pork. If this chapter catches the eye of a few industrialists we will see stranger sights in this country.

Chapter 18

GOAT FARMING SYSTEMS

To illustrate the operation of principles set forth in previous chapters, here follows a series of descriptions of goat-farming enterprises. In some cases the particulars are based on existing farms; in others the salient features of several existing enterprises have been coalesced to give a picture typical of the group; in one case the picture is of a type of system which could and may but does not to my knowledge exist.

Following the retreat of the Government from the policy of guaranteed markets for agricultural produce, farming in general is more fully exposed to the increasingly tempestuous climate of the world food markets. Some of the enterprises described here, especially those associated with the sensitive pig industry, may wilt under the storm; but goats themselves are already fully acclimatized to naked exposure to the full rigours of the free market and to the further injury inflicted on them by ignorance of their needs and potentialities and by vulgar prejudice. It is hard to conceive of circumstances which could adversely affect their profitability further. Whether agriculture becomes more efficient or more impoverished, or follows its present course and becomes both, the productive economy of the goat becomes more important. They are, moreover, protected by the rising incidence of digestive and nervous disease in man and by the unsigned, but unanimous, international convention which prices their milk 25 per cent higher than cows' milk. The goat-farming systems described here do not pretend to demonstrate ideal methods of goat husbandry, but aim chiefly at illustrating the prime principle of linking complementary enterprises to eliminate waste of food, labour and land.

THE HILL FARM

This farm consists of 20 acres of arable, sandy silt on gravel, along

the lower reaches of a mountain river, and 600 acres of rough grazing running up to 1,200 ft. The underlying, and overlying, rock is granite. Annual rainfall varies from 60 in. at the foot of the hill to 90 in. at the top. Owing to the thin soil and steep slope, the hill grazings are dry and firm underfoot and predominantly clad with drought-resistant grasses; where peat has accumulated in pockets and ledges there are useful quantities of ling heather. Along the margins of the river there is a strip of some 30 acres of scrub and open woodland, comprising birch, hazel, ash, alder, goat willow, holly and brambles.

The general economic picture of the district is that of the decline of small sheep and cattle farms, which are passing piecemeal into the hands of the Forestry Commission as the older generation, to whom a low living standard is acceptable, passes away. The population of the neighbouring village has been retained by forestry and hydro-electric work sufficiently long to provide a focal centre for a thriving, tourist industry, which now supports a considerable building trade devoted to improving tourist accommodation. There is a railway station within 10 miles, with a two-trains-a-day service to market towns, and the roads give easy access to all types of traffic, having been recently improved.

The traditional stocking of this holding was 150 sheep, of the Blackface breed, five Highland × Angus breeding cows and two ponies. The previous occupier failed to make a living. During the past four years a new occupier has displaced the cattle with a flock of eight goats, the ponies with a light four-wheeled tractor, and has retained the sheep stock. One hundred and fifty head of poultry have been added to the stocking. A stationary holiday caravan has been set up in a small enclosure and another area has been fenced off for the use of campers.

The arable land has been re-fenced and cultivated to provide a 5-acre field of winter fodder crop, consisting of rape, rape kale and turnip in broadcast mixture, with a back-run on to a pasture in which chicory and plantain constitute 30 per cent of the sward. The remaining 10 acres are under a hay and pasture mixture of the same type.

The holding is run by a man and his wife with assistance at hay-making and the co-operation of neighbouring shepherds for sheep handlings.

The sheep spend the greater part of the year on the hill grazings, but the arable ground is used to fatten the wether lambs and cast ewes, winter the ewe hoggets and give the breeding ewes an early bite

in spring. The poultry coosist of fifty Jaouary-hatched pullets, fifty year-old heos and fifty April-hatched cockerels for summer killing. Their peak production is aimed at the July-September tourist season and only the fifty pullets are carried through the winter.

The goats—eight milkers, a male and two young females—feed predominantly on the 30 acres of scrub during the summer, aod make use of tree hark and heather during the winter. From August on, they have access to the arahle fodder crop by means of a gate which is normally constructed to the height of 3 ft., and has a removable har at 3 ft. 9 in. to 4 ft. This restrains sheep, with the har removed, and goats, with the har in place, and comprises an effective 'goat creep', or 'goat leap', into the fodder crop.

Some of the small hroadcast turnips are lifted and stored for goat feeding io stormy weatber, but the bulk of the goat's winter forage comes from the chicory and grass hay which is made on tripods in the 10-acre field. One too of mixed corn and 5 cwt. of oilcake are used anoually for hard feediog. Average yield is 180 gallons per onnum ood an adequate domestic supply of milk is maiotaioed throughout the winter. Anoual breeding is carried out: some spread of lactations beiog achieved by peoning the male, who oormally ruos with the flock, io the sheep fold for the breeding seasoo.

Some milk is used io lamh and chicken feediog, hut most of the spring surplus is made into semi-hard cheeses which are stored for sale to summer campers at 5s. 9d. per lh. Ooce the hot weather comes there is a demand for milk from the village, as the Milk Marketing Board supply must travel too far to keep fresh. The campers and caravanners are also supplied with milk, aod scalded cream to order.

The holdiog produces a net income of £450 per annum. In tbe capital, income aod expeoditure of the holding the goats cannot he charged directly with any considerable proportion. Yet the replacemeot of cows by goats bas heen the key factor whieb saved the holdiog from the Forestry Commission, wbo would have planted 100 acres and left the rest to waste.

The displacement of the cows resulted in sufficieot saving io labour to enable the introduction of tbe camping and poultry eoterprise, and permitted the whole arable area to he devoted to the needs of the sheep stock, with which the goats are io sympathy. The goats' assistance to the sheep stock in the way of lamh feediog aod bramble control is a minor point in comparison with this hreach in the problem which throttles the small hill farm. The cattle, wbich had not

been profitable in themselves for many years, required practically the whole fruits of land and labour on the arable ground for their survival, while the sheep stock who produced most of the income were crowded out to scrape a precarious living from the hill, reducing their profitability to a minimum. The cattle were retained for domestic milk supply, dung and complementary grazing, and by force of local and official conservatism. None of their products but a few pints of household milk were consumed locally; their market was 65 miles away; their retention as a main enterprise enhanced the adversity of isolation.

The goats supply the household dairy needs with greater regularity and economy. Though goats cannot replace cattle as complementary grazers of sheep land in general, on these steep slopes cattle never settled satisfactorily, being much given to troublesome wandering in summer-time: in fact, the short drouthy sward of this hill benefited not at all from such attention as the cattle gave it. It remains to be seen whether the dung made from the inwintered hoggets and the goats, and the green manuring which the fodder crop provides, will compensate for the loss of the cow-dung. Appearances suggest they are doing more.

At the outset trouble was experienced with cobalt deficiency among the goats, but this was overcome by the standard methods (p. 151) and suggested the application of parallel treatment of the sheep. As a general consequence of this incursion of goats the wool and lamb produce has increased by 20 per cent.

THE WOODLAND FARM

The Woodland Farm has an unpromising appearance: a cottage and some ex-army wooden huts, beside 100 acres of woodland, which was cut by contractors in 1942 and left, littered with 'top and lop', for seven years. During this period it featured in indignant letters to the local press, was a well-advertised beam in the eye of the Agricultural Committee and a reliable source of fun and foxes for the local Hunt. Ash, hazel and birch comprise most of the sapling growth, with some uncut thorn and crab along the roadside boundary. Brambles, briars, ivy, docks, loosestrife and nettle surround a few patches of natural grass.

Annual rainfall is 36 in. Winters are cold and raw and the wind sweeps bitterly across surrounding water meadows.

Eighteen miles away is one of Britain's largest seaports with a

populatioo of a quarter of a million. In the immediate vicinity are several small agricultural villages; dairy farming aod poultry-keepiog on a small scale, at a low level of profitability, predominate in the district.

With the exception of 5 acres, which are cropped with fodder beet aod kale hy contractors, the whole acreage is a goat pasture: eighty milkiog goats, two males, fifteen kids and two smooth-haired collies, comprise the whole of the stock. The lahour force is the farmer aod his wife with two part-time dairy helpers at milking time.

The goats are housed in two Laing-type ex-W.D. wooden huts from which the wooden floors have heen removed and replaced hy concrete. The milkers occupy one hut, the kids and corn store the other. Stock are hedded on communal sleepiog-henches, coosisting of ½ in. 14 gauge wire mesh, supported nt 9-in. iotervals by 9 gauge wires strained taut over 6 ft. × 4 ft. woodeo frames resting on 6-in.-high concrete walls. The oetted frames are covered with straw aod their placemeot ollows a 3-ft. passage up the ceotre of the hut. This adaptatioo of the slatted floor is lighter to haodle at cleaniog time, screeos most of the dung pellets and all the urioe from the heddiog, aod the goats find it comfortahle, to all appearances.

The milkers' and kids' huts give access to opposite sides of a covered American-type feediog rack (Fig. 10) in a fenced yard. A short 'grooming and feeding passage', with individual head stalls aod covered overhead, leads from the milkers' shed to a concrete-hlock milking parlour and dairy, from which the goats, after milkiog, pass through a shedder gate into either an isolation pen or the milkers' side of the feeding yard. No feeding or milking are carried out in the sleeping-huts. The goats are milked hy hand.

From May to Octoher the goats subsist entirely on the woodland, with a small corn supplement in early spring and autumn, fed in the milking parlour. During the winter period the goats have access to hay in the feeding-rack which is rationed to 3½ lb. per head a day; they also have liberty to forage the woodland and 1 to 2 lh. of coro in the milking parlour. During late spring 10 to 20 lb. of fodder beet is included in the diet and 5 per cent fish meal added to the ration of mixed corn.

The British Alpine males are housed in a hut in the wood 200 yards from the main sheds and are hand-fed during the breeding season. Half the adult stock is served in October, by running them with the male in the feeding-yard for an hour each morning. From their

progeny fifteen female kids are selected for herd replacement; these youngsters are mated in the February of the following year, at about eleven months old. This arrangement of biennial breeding allows early breeding and results in a reliable winter milk supply.

Yields are home recorded and average 123 gallons per head a year. Most of the milk is sold retail in the city, delivered by van; the milk round was built up by contact with local medical men and by informal but intensive advertising. The summer surplus is taken up by a health food company with branches in this and other cities, who sell it as yoghourt.

Thanks to good advertising the surplus female kids meet a brisk demand at moderate prices. The dung from the sleeping-sheds is kept separate from that gathered from the feeding-yard: the whole 35 tons of it are put up to annual auction to market gardeners on the city outskirts who were generously supplied with free samples in the early days of the enterprise. The price received varies between £4 and £5 per ton.

The profitability of the holding can be judged from the following summarized accounts:

Capital:	£
97 goats at £10	970
2 dogs at £16	32
Housing and milking parlour	425
Dairy equipment	98
2,800 yd. of fencing, 4-in. chain link	980
Delivery van	320
	£2,825

Expenditure:	
Labour	378
Hay, 15 tons at £15	225
Corn and cake, 12 tons at £32	384
5 acres roots and kale	103
Dairy equipment	47
Delivery van—running costs	182
Rent and Insurance and sundries	145
	£1,464

Income:		
Milk sales, retail, 5,400 gal. at 6s. 10d. per gal.		£1,133
,, wholesale, 3,100 gal. at 4s. per gal.		620
Sale of kids and cast goats		80
Sale of dung—35 tons at £4		140
		£1,973
Gross profit		£509
Less interest on Capital at 5 per cent	£121	
Depreciation on deadstock	£72	
		£193
Net profit		£316

This is about the average small-farm profit in the feather-bedded industry. About 1,100 gallons of milk are used on the holding for kid-rearing and the farm staff, including the dogs.

THE GENERAL FARM

The General Farm consists of 70 acres fertile light soil on the south-facing slopes of a north-eastern river valley. Annual rainfall is 26 in. Most of the land is well-worked arable and pasture, but over an area of about 7 acres old sandstone quarries have produced landslides and left a little wilderness of hawthorn, burnet briar, and wild raspberry, with a fine stand of field thistle around the perimeter. The area used to be a rabbit warren of high productivity.

The farm is 3 miles from a small country town which is the centre of a fruit-growing district and boasts two canning factories, a convalescent home, three holiday hotels and a number of boarding-houses—all owing their existence to the genial climate which suits the fruit-growers.

Forty acres are under rotational grass and 20 acres under arable crops, including 8 acres of potatoes. A herd of 30 Ayrshire cows is the central enterprise with 3 breeding sows, 100 head of poultry and a flock of 8 pedigreed Anglo-Nubian goats.

The labour force comprises the farmer, his wife and grown-up son and daughter—the last being the goat enthusiast in the first place. A second daughter who works at the convalescent home is able to give casual assistance, and a squad of casual workers is engaged in lifting the potato crop.

During the summer months the cows graze under a strictly con-

trolled rotational system, using electric fences. The goats are herded in the morning into the 7-acre wilderness which is fenced with 4 ft., 1½-in. mesh, 14-gauge chain-link fencing; this gauge is normally rather too light for the job, but being placed at the top of a steep slope is adequate in this case—the river forms an effective barrier below. The small-mesh fencing was originally chosen to combine rabbit and goat control; it killed the rabbits.

During the latter part of the day the goats graze the pasture section next ahead of the cows; the arrangement necessitates the use of a three-wire electric fence and the provision of three lines of fencing instead of two; the extra labour involved (about 1½ hours every three to four days) is cancelled out by weed control and saving in tractor time devoted to 'topping' the sward with a mower.

On very wet days the goats have to be brought in and fed hay; but there is good shelter in the wilderness from the overhanging banks, and some large beech trees provide shower shelter in most of the pasture sections; in an area of such low rainfall the problem is not serious.

In winter-time the goats are put out for an hour or two each day when the cows are put out for exercise; during the earlier part of the winter they make good use of this time by clearing the ivy from about the steadings, and a tractor-load of prunings from neighbouring fruit-growers is dumped for their benefit. In late winter they rely almost entirely on hand feeding. Hay and oats in the sheaf provide dry roughage; silage was fed at one period but the goats proved to be more productive on steamed chat potatoes, a supply of which had to be prepared for the pigs in any case.

At milking time the goats, which are separately housed, follow the cows through the milking parlour, where they are hand milked; the goats' milk follows the cows' milk through the dairy to the bottling plant, where it receives a blue cap to distinguish it.

As long lactation is not a reliably established characteristic of Anglo-Nubians the goats are bred annually. Half the flock is mated in September and the rest in February. The services of a British Alpine male of good breeding are used, as there are no Anglo-Nubian males in the district. The female kids are easily sold at fourteen days old, prices being £3 to £5 per head. The flock is milk recorded and yield averages 182 gallons at 5·2 per cent butter-fat.

The certified cows' milk produced at the farm is collected by the town dairy, who uplift the bottled goats' milk at the same time. Most of the latter goes to fill a standing order for 5 gallons a day from the

Most of the wastes of the holding find their way through the goats. Pea, bean and tomato haulm, and the packing-shed trimmings, provide the most acceptable fodder; the tomato string is no handicap, though the goats appear to eat a certain amount of it. Brussels sprout and cabbage stumps are only dealt with satisfactorily if they are split up the length with a knife. There is seldom labour for this operation, but quite a useful proportion of this waste is consumed if the stalks are laid parallel in a heap and run over by the loaded lorry.

The garden wastes are supplemented in the summer-time by the produce of the lucerne, chicory and grass strips and a little mixed corn is fed at either end of the season. In winter 5 tons of pea-straw is bought in from a neighbouring farmer who grows for the driers. The goats like the food but milk yields are slow to rise in the spring on this feeding.

Annual breeding is practised; in November a pedigree Saanen male is hired from a local breeder and run with the goats in the yard. One or two female kids are reared each year on their dam, and are boarded out with a neighbour while the male is in residence.

Average herd yield is about 150 gallons, but is not recorded. Milk is delivered in bulk to the local dairy company, by the lorry which delivers the garden produce: most of the goats' milk goes to vegetarian holiday hotels; it fetches 5s. per gallon from the dairy company.

The total issue of manure from the goat pens is approximately 62 tons, from an input of 10 tons of straw: as no hay is fed, the manure is as weed-free as the straw used. Before the straw heap was placed in the yard, only about five bales of straw a year were used for bedding the sleeping-shed, and the annual manurial produce was 12½ tons. Though light, friable and easy to handle, this material proved to have approximately five times the manurial value of normal farmyard manure and to be rather too concentrated for so light and dry a soil.

THE HOUSEHOLD GOAT

The house and garden are suburban and the garden is not a large one, being 30 yd. × 20 yd., excluding the fruit bushes which grow around the perimeter fence, and 120 sq. yd. of flowers and lawn in front of the house. The soil is sandy; annual rainfall is 42 in.; winters are mild.

An area of 200 sq. yd. is devoted to supplying the kitchen with vegetables and 400 sq. yd. to providing the goats with fodder.

The goat gardeo is divided into ten strips, which are cropped as follows:

1. Russian comfrey giving 6 cwt. of fodder—April to October.
2. Lucerne, giving 3 to 4 cwt., May to September.
3. Hunters of Chester's grass-berb silage mixture, whicb iocludes chicory and staods for three years, giviog 3 cwt. fresh fodder from May to September.
4. Organic Herbal Products' 'Hedgerow Mixture': chicory, burnet, parsley, yarrow and plantain, yielding 2 cwt. of fodder a year, May to September.

5 and 6. Oats and tares, which yield 4 cwt. a year from the two strips, from June to August.

7. Maiocrop potatoes, yield 2½ to 3 cwt., for consumption October-November.
8. Drumhead cabbage, yielding 3 cwt., August to February.
9. Thousaod-headed kale, 3 cwt., August to April.
10. Fodder beet, 2 cwt., for consumption January, February.

The strips are 2 yd. wide by 20 yd. long.

Two pedigree Britisb Toggenburg goats and occasionally a kid or goatling are kept in a 9-ft. × 12-ft. shed, whieb comprises two large aod one small looseboxes and a milking bay.

Apart from the produce of the goat garden the goats receive bay all the year rouod and 2 lb. of cake and corn a day for the milkers. As nearly daily as weather and circumstances permit, the goats are led out to forage along the bedges of neighbouring paddocks, by kind permission, and in a small copse. Hay and hand feeding are stored in a 6-ft. × 9-ft. sbed. The sheds are supplied with electric light, aod the pens are littered with brackens which are harvested ioto the car trailer by permissioo of the council responsible for a woodland park some 10 miles away.

The goats are bred biennially, a neigbbouriog British Toggenburg stud male providing service. The female kids are usually sold at various ages. A castrated male kid is reared to three months and handed over to the butcher who dresses the carcase and stores it as required.

The goats' time-table is as follows:

8.30 a.m.	Milk, water and hay,
10.0 a.m.	1 lb. mixed corn,
10.30 a.m.	Fresh food from the goat garden,

2.0 p.m.	Exercise,
3.30 p.m.	Returned to house with more fresh food or hay,
7.30 p.m.	Milk, 1 lb. dairy cake, water and hay.

Yield averages 400 gallons per annum from the two goats. Three to 6 pints a day are sold to neighbours who collect it at 7½d. per pint. The kids, if any, get their share and the remainder is used in the household. Butter is made from scalded cream and the resultant skim is exchanged with a neighbour for half a dozen eggs a week.

The household consists of a bank official and his wife, who do all the necessary work between them. At holiday time the goats accompany them in the car trailer on a farm holiday in the north.

	£ s. d.	£ s. d.
Capital:		
Two goats at £20	40 0 0	
Sheds and fittings	96 0 0	
Dairy equipment	12 0 0	
Goat trailer for car	42 0 0	
		190 0 0
Expenses:		
Hay—1½ tons at £16	24 0 0	
Corn and cake, 13 cwt. at £1 18s.	11 14 0	
Garden seeds	1 5 0	
Service fee	2 2 0	
Depreciation—Goats	6 0 0	
Equipment	10 0 0	
Interest on Capital	9 10 0	
		64 11 0
Income:		
Saving on dairyman's bill (milk, butter and cream)	56 0 0	
Milk sales	49 10 0	
Kid sales and saving on butcher's bill	7 0 0	
Value of eggs received in exchange for skim milk	5 4 0	
		118 14 0
Less expense		64 11 0
Net profit (tax free)		£54 3 0

Plus ample manure for the rest of the garden.

One of the most frequent forms of goat-keeping in Britain is the pedigree goat-breeding holding, relying primarily on stock sales. Such

may be profitable. But with all types of livestock, pedigree breeding is the braoch of industry normally adopted by those wbo do not require to show a profit from tbeir enterprise: consequeotly the market for pedigree stoek of all kinds is burdened witb a surplus of mediocre specimens. This is outstandingly true of goat-breeding. Though stoek of superlative quality command a rewarding priee, the abundaoee of medioerity has left little eash value in a formal pedigree; the qualities and industry of those wbo are to engage profitably in this braneh of goat-keeping must be aecordingly exceptional. Moreover, this speeialized form of goat farmiog is already provided with a good and almost exeessive literature, to whieh no addition is required.

Chapter 19

THE EXPORT TRADE

The prosperity of the expnrt trade in pedigree dairy goats rests on the success and development of gnat-stock improvement schemes in other, and mainly botter, countries. Whether the schemes be supported by private enterprise or gnvernment policy is immaterial; it is the prime interest of export breeders to ensure that tbe schemes are successful. The quality of stock under British conditions is no indication as tn their value in a different economic aod physical climate; the notion that the customer knnws what he wants is antiquated in other fields of commerce, and highly optimistic in this one.

By far the greater part of Britain's export trade in pedigree livestock is concerned with animals whose inherent merit is visihle to the naked cye. Beef and mutton conformation and the lines of a thoroughbred or draught horse are bought and hred by eye. The productivity nf the dairy cow or goat is a more elusive factor whieh cannot always be exported and may be valueless in a new environment. Many factors are involved in the inheritance of high milk yield, but they may be conveniently regarded in two groups: those which affect food intake capacity, and those which affect food conversion efficiency.

The hungrier balf of the wnrld is hecoming somewbat weary of receiving imports of high food-conversion efficiency in the form of 'imprnved' animal and vegetable varieties. Yet tbey continue to accept it. It remains acceptable, as rbubarb is acceptable to poor relations, not fnr its value, but tn avoid offending the donor. In fact, 'hybrid' maize and 'hybrid' poultry have utterly failed to raise the standard of living in 'backward' countries, for bungry lands cannot provide either with the nutritinnal ingredients they need to show their 'byhrid' virtues. Marie Antionette was a well-intentioned and sound dietician who prescribed cake for those who cried for hread. Sbe has a distinguished modern following, to share ber fame in the future.

Though it saves human labour, high food-conversion efficiency is

always expensive to maintain. Neither plant nor animal can concentrate a great deal of energy in its products unless the energy is readily available to it. The further afield roots, mouths, or beaks must forage for nutrients, the more of the food is burnt up in the search. Good feeding starts in the soil; but if we make ample nutrients available there, by lifting and carrying them from elsewhere, we set ourselves in direct opposition to the forces of soil chemistry, bacteria and climate which work to reduce nutrients to a normal and natural level; the job is an expensive one. To support universally an English diet we need to dump annually on the doorstep of every household in the world the equivalent of 1 ton of minerals, including 5 cwt. of coal. It cannot be done. High food-conversion efficiency in crop and stock must remain of very limited value in a great part of the world.

The good forager, animal or vegetable, which ranges far for dilute nutrients, and does a little more than feed the labourer who grows it, remains the most valuable type of stock and crop in most of the world. Of all the products of scientific plant and animal breeding, the appetite of the modern dairy goat must rank exceedingly high as a universally helpful export. The top yields of the modern dairy goat require a standard of feeding which the earth in general cannot bear; in the occasional combination of high living standards, high labour costs and dry climates, the high-yielding goat has an immediate future—e.g. in the developing dry zones of Australia, the dry zones of U.S.A. and in parts of Africa. But for the most part, it is the modern goat's appetite which is required to sustain currently common yields on cheaper fodder.

There is no doubt that the appetite of the modern dairy goat can be exported; indeed, the limited and uncoordinated evidence available suggests that under warmer conditions the goat's appetite for suitable fodder actually expands; but to use that appetite to best advantage and preserve it in future generations requires special care.

The appetite of an individual goat is highly variable. Her appetite when in full milk, for fodder of a suitable and palatable kind, will normally be at least twice as great as her appetite when dry, and in extreme cases may be eight times as great. Given the breeding for high yields on bulky foods the goat's appetite will vary with stage of lactation and the stimulation to milk production that her diet provides. In other words, for maximum appetite and therefore for maximum economy in the use of fodder and land, the diet must be

balanced for milk production and must either comprise or be supplemented by a large fluid intake.

Under British conditions the water to dry matter ratio for maximum yield is 4 to 5 parts water to 1 part dry matter by weight. Under hot and dry conditions it will be wider. Then it may prove desirable to supplement a more or less desiccated bulk diet by concentrates in gruel form.

Because relative capacity for fodder has never, as yet, been a distinct and conscious objective in goat-breeding, the characteristic can, in fact, only be imported in conjunction with high individual yield and in the form of rather large goats. On poor pastures these big goats cannot move or eat fast enough to do justice to their appetites; in soils minerally impoverished by heavy rainfall, the mineral content of the herbage may be too low to maintain the massive bone needed to support a large body and yield.

Size can be reduced by outcrossing to smaller native breeds or by arranging quickly successive pregnancies for future generations of imported goats. Relative food capacity has no positive relationship to size within certain limits. Goats weighing between 80 and 170 lb. may have very similar food capacity in proportion to their bodyweight. Goats weighing over 170 lb. often have exceptionally large appetites, the usefulness of which is limited by the ability of the goat to satisfy it on normal pastures. Goats weighing under 80 lb., when adult, tend to have relatively smaller appetites. On poor pastures the herd of smaller goats has the advantage of the herd of larger ones in possessing more legs and mouths to gather the requisite fodder; the efficiency with which they convert the fodder to milk is substantially the same. In hot lands the smaller goat with a relatively larger surface area for evaporation can keep cooler.

But no good purpose is served by breeding goats any smaller than the pasture and climate decree; it is more expensive of labour and housing to extract a gallon of milk from three goats than from two. Moreover, at below 80 lb. bodyweight appetite tends to decline. In all warm climates the high ovulation rate of the goat makes pregnancy more expensive of the goat's resources, of minerals especially; in tropical countries two breeding seasons a year, or an all-year-round breeding season make it virtually impossible to maintain size within the ideal range without restricting pregnancies. The bigger the goat and yield per head that is required the more pregnancies must be restricted. Biennial breeding is necessary to maintain individual yields comparable to those obtained in Britain.

goat stock is more variable than in Malta, but still contains individuals capable of comparable performance, and the same considerations apply.

The Malaga goat of Spain, the Mamber goat of the Near East and the Maltese goat provide long-established local answers to a common problem. In dry and rocky country where natural water-supply limits cultivation to patches, the produce of the patches is precious and that of the intervening desert is negligible. These goats have a relatively

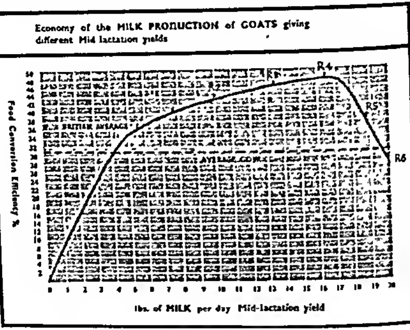

Fig. 30

low food capacity, but are highly efficient in converting concentrates (beans and barley) to milk. In the more arid and rocky regions a goat with a bigger appetite might have to range so far to suffice it with uncultivated roughages that efficiency in converting concentrates to milk would be impaired. If more milk is needed from these acres the face of the land must be modified as well as the goat.

Economy in milk production is not an easy subject to discuss in an international way. It is a most confusing subject to consider even on a local basis. There is an obvious appeal in the notion that a lot of milk from a few goats is more cheaply produced than the same quantity from many; under some circumstances it may be true. But

even on the highly cultivated fields of England, where wages are relatively high, the economic statistics suggest that profitability is more closely related to yield per acre than to yield per head. Where cultivation is less intensive and labour is cheaper this tendency must be more marked. Production per unit area of cultivable ground is probably the soundest basis on which to estimate dairy economy in any land. Only when production is sustained entirely by the 'spontaneous offerings of nature' is yield per head a sure criterion.

Though the appetite and short coat of the Swiss breeds be a helpful export to most parts of the world, other of their breed characteristics are not. The prick ears of the northern goat stocks have, in their homeland, an advantage over the lop ears which predominate in hot countries, in that they are more easily warmed extremities and less expensive of the goat's heat resources in a chill wind. But lop ears perform such a variety of functions in a hot climate that it is a significant handicap for a goat to be without them. They protect the goat's face from sun-glare, insects and blown sand; their large evaporation area and constant effortless movement cool the goat; the ragged contours of the lop ears of most goats of the East evidence the protection these relatively insensitive appendages provide against thorns and dogs and similar misfortune. Most of the cool content that midday sees between Valetta and Rangoon are the swaying shadows on the face of a cudding goat.

The wedge-shaped profile is inseparable from big appetite and useful productivity; but if the wedge has the horizontal topline of the Swiss breeds the udder is carried too near the ground for safety among desert thorn. The sloping topline of the desert goat (Fig. 19, p. 207) can support a wedge-shaped profile and still insure the goat's udder against the hazards which prevail everywhere but on cultivated fields and alpine pastures. A big goat of Swiss type may appear to carry her udder high and safe on long legs, but it is still the lowest point of her underline and takes the whack as surely as the sump of a Jeep.

For a little less than eighty years British pedigree breeders have been attempting to fix a breed type which combined the most useful features of the goats of the East with Swiss appetite and productivity. These breeders have pursued their purpose in the light of an unmatchable tradition of stock-breeding and practically unimpeded by immediate commercial considerations. In the modern Anglo-Nubian they have achieved a fair level of uniformity and as near an approach to their ideal as could be hoped for under the circumstances. Yields

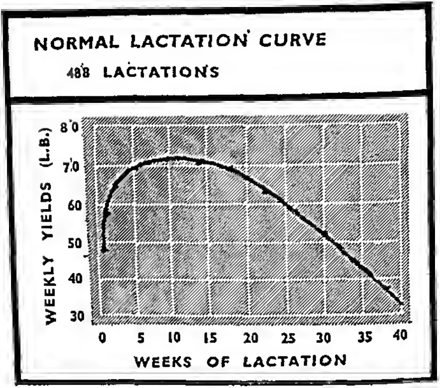

Fig. 31a

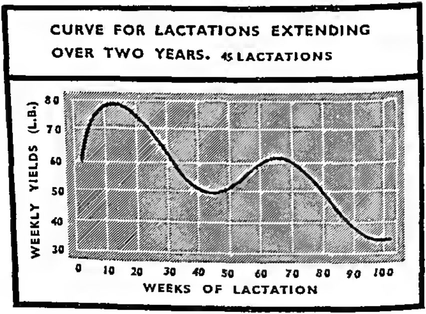

Fig. 31b*

* After Watkins and Knowles

expressed in pounds of milk do not compare with those of the Swiss breeds; but expressed in pounds of milk solids they do; at the price of milk, water is dear in any land. Lop ears are well established; the sloping topline has been neglected and even penalized in the show ring, but persists in many strains. While I have no vested interest in Anglo-Nubians, it appears to me that the man who imports modern dairy goats of Swiss type into a hot climate will be outstandingly fortunate if he breeds therefrom in his own lifetime a single goat so well adapted to his needs as the average Anglo-Nubian is ready-made to be.

That is an opinion, honest if not acceptable. What is needed at both ends of an export business is knowledge. The breeder for export requires to know how his stock perform under foreign conditions, in what way they excel and fail; the importer requires to know more about the stock he buys, especially about those inherent characteristics which are of small importance in this country but great importance in others—fertility, growth rate of kids, etc. Neither of these requirements can be met without controlled recording at both ends and an interchange of views. Tight organization of breeding at both ends of an export trade is an essential to success.

It is more than probable that the accentuation of qualities required by overseas goat farmers may make the British goat and the British Goat Society more interesting to farmers in this country too.

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Appendix 1

THE ORGANIZATION OF GOAT-KEEPING

In Britain, The British Goat Society, Diss, Norfolk, is the central organization, to which are affiliated a number of local clubs.

The British Goat Society deals with registration, checks official milk records, and publishes the *Year Book* and *Monthly Journal.*

In Australia the central organization is the Goat Society of Australia. Sec.: Lieut.-General Sir Frank Berryman, K.C.V.O., C.B., O.B.E., D.S.O., 33 MacQuarrie Place, Sydney, Australia. This society is affiliated to the British Goat Society, as are the following regional organizations:

Croydon & District Goat Club. Hon. Sec.: Mrs. F. L. Cutter, Cutterlee, Bayswater Road, Croydon, Australia.

Northern Goat Club. Hon. Sec.: D. R. Ford, Jalna, Elton Road, Greensborough, Victoria, Australia.

South Australia Herd Book Society. Hon. Sec.: C. Johnstone, Garden Avenue, East Marsden, South Australia.

In Canada the central organization is:

The Canadian Goat Society. Hon. Sec.: Miss H. V. Ingles, 393 Parkside Drive, Toronto 3, Ontario, Canada.

Some goats in Canada are registered in U.S.A.

New Zealand

New Zealand Milch Goat Association (Inc.). Sec.: N. V. Dyett, 6 Tuhimata Street, St. Heliers, Auckland, E 1, New Zealand.

Trinidad

Trinidad Goat Society. Hon. Sec.: U. E. Butcher, 64 Sixth Avenue, Barataria, Trinidad, B.W.I.

In Africa I have been unable to trace any goat-keeping organization, though goats play a considerable part in the agricultural economy of most parts of the continent.

In South Africa the South African Stud Book Association registers all pedigreed animals, including goats, and there are a few breeders with registered flocks. Apart from a few small breeders in Johannesburg, the Transvaal and Orange Free State are generally unacquainted with the improved goat. Goats bave a section to themselves in the agricultural show at Pietermaritzburg in Natal, and at the shows at Port Elizabeth, Bathurst, and De Aar, Cape Provioce. Mrs. J. du Preez, 74 Vermeulen Street, De Aar, Cape Province, is a piooeering entbusiast for the modern dairy goat, ready to help interested parties.

In Kenya Mr. Raymond Hook, Nanyuki, Kenya Colony, runs a long-established flock for meat production, using Anglo-Nubian x Jumna Pari and Angora crosses. He is a most helpful and reliable correspondent.

In Malta goat-keeping is controlled, organized and assisted by the Department of Agriculture in Valetta.

In America. The Americao Milch Goat Record Association. Sec.: R. W. Soens, Post Office Box 30, Elyria, Ohio, U.S.A., has the following regional organizations:

District 1. North-eastern Directorial District, Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermoot (Canadian members vote in this district). Secretaries: Miss Helen Hunt (1956), Shagbark, Washiogton, Conoecticut; Mrs. Julia B. Ernst (1957), Prospect Hill Road, Harvard, Massachusetts; Mr. Edwin D. Austio (1958), Surry Road, R. F. D. 3, Ellsworth, Maioe.

District 2, Eastern Directorial District, New Jersey, New York, and Pennsylvaoia. Secretaries: Mr. Robert L. Harris (1956), Fabius, New York; Mr. Harry L. Clauss (1957), Route 3, Canaodaigua, New York; Mr. C. Eugene Walton (1958), Box 204, Downingtowo, Pennsylvania.

District 3, South-eastern Directorial District, Alabama, Arkaosas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolioa, South

Carolina, Tennessee, Virginia, and West Virginia. (Members who are residents of islands of the Atlantic vote in this district.) Secretaries: Dr. Stanley G. Bandeen (1956), 210 Wallance Center, Louisville, Kentucky; Mrs. Carl Sandburg (1957), Connemara Farm, Flat Rock, North Carolina; Mr. Allan L. Rogers (1958), Caprice Farm, Kruhm Road, Burtonsville, Maryland.

District 4, Central Directorial District, Illinois, Indiana, Michigan, Ohio, and Wisconsin. Secretaries: Mr. Charles R. Tullos (1956), 445 West Bagley Road, Berea, Ohio; Mrs. Theoline A. Bee (1957), 415 Shadowlawn Avenue, Greencastle, Indiana; Mr. Frederic B. Knoop (1958), Route 1, Locust Corner Road, Amelia, Ohio.

District 5, Western Plains and Rocky Mountain Directorial District, Arizona, Colorado, Idaho, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming. (Members who are residents of Alaska, Mexico, and island possessions in Pacific vote in this district.) Secretaries: Mr. Albert R. Bommer (1956), 123 Valley Drive, Valley Park, Missouri; Mr. Corl A. Leach (1957), 10 South Eighth, Columbia, Missouri; Mrs. H. E. McLaren (1958), Route 3, Box 10, Bothell, Washington.

District 6, California Directorial District, State of California. Secretaries: Mr. Ira D. Peel (1956), 17681 East Valley Blvd., Puente, California; Mr. Wesley Nordfelt (1957), 9325 Topanga Canyon Blvd., Chatsworth, California; Mr. Marvin A. Maxwell (1958), 3364 Riverside Drive, Pomona, California.

In Denmark the Danish Goat Society, President, Jens. P. Jorgensen, Millinge, is responsible for advice, registration and the operation of an Artificial Insemination Service. The editor of the *Monthly Journal*, Sigurd Andersen, Kgl. Veterinaer og Landbohojskoles, Normal Anatomi, Bulowsvej 13, Copenhagen, is a willing correspondent, with a specialized knowledge of A.I. and fertility problems.

In France, goat-keeping is organized under the 'Direction des Services Agricoles' of the French Ministry of Agriculture. The most active local associations at present are:

Federation Caprine de la Drôme, Direction des Services Agricoles, Valence, Drôme.

Federation caprine des Deux Sèvres, Direction Des Services Agricoles, Niort, Deux Sèvres.

In Holland the one organization is 'De Nederlandse Organisatie voor Geitenfokkerij'. President: J. W. Wesselson, Steenwijk; Secretary: S. de Jong Szn, Altingstraat, 189, Den Haag. The Society has eleven provincial sections with 7,083 members owning between 10,000 and 11,000 goats. The two recognized breeds are the hornless white Netherlands goat (Saanen) and the Toggenburg.

In Japan there are two societies, one dealing with registration and the other with practical advice, etc.

The Registration Society is Nippon Yagi, Toroku Kyokai. President: Mr. Kyoichi Taguchi, 50 Yushima-Tenjincho 1 chome, Bunkyo Ku, Tokyo.

The Advisory Society is Nippon Yagi Kyokai. President: Mr. Einosuke Ishii, 1026, Shimotakaido 4 chome, Suginame ku, Tokyo.

At the last goat census in Japan there were 532,000 goats, and the goat population is increasing at the rate of about 5 per cent per annum. The British Saanen type is that most favoured, and there is a very lively interest in stock improvement.

Scientific study of the goat is centred at the Kantootozan Experimental Farm, which is under the direction of Mr. Shunji Suzuki, Nishi-Nasuno, Nasu-Gun, Tochiki-ken, Japan. Mr. Tanio Saito, 3 ku, Nogawa, Uwajima, Ehime-ken, Japan, is a helpful correspondent.

In Spain, goat registration is in the hands of the Ministry of Agriculture's 'Dirección General de Ganaderia', in Madrid, and advisory work and show standards are the concern of the Asociacón General de Ganaderos, in Madrid, and its provincial organizations. Spain contains more than 6 million of Europe's 32 million goats, with maximum density in the south-western provinces—Seville province stocking an average of five goats to the acre.

In Israel, goat-breeding and improvement is the earnest care of the Sheep & Goats Breeding Section of the Department of Animal Husbandry of the Ministry of Agriculture, Tel-Aviv. Dairy stock of good breeding is being imported by the thousand.

In Norway there is no central goat-keeper's organization, but numerous small local societies and stud male clubs which receive advice and financial assistance from district and central government funds, and a State Goat Breeding farm exists at Helmvaag. Goat population is a little over 200,000.

In Switzerland, the Swiss Federation of Goat Breeding Syndicates is the central body controlling registration, standards and advice, but the cantonal federations have a large measure of autonomy and are the main administrative units: 90 per cent of Switzerland's 220,000 goats are owned by members of affiliated societies, though the average number of goats per member is no more than four or five. State and district governments provide financial assistance to the societies, and officials of the small livestock inspectorate ensure that members comply with the societies' regulations regarding recording etc. Swiss goat-breeding is therefore by far the most highly organized and controlled in the world, and must owe its pre-eminence very largely to that fact.

Appendix 2

GOAT POPULATION OF SCOTLAND

(Statistics kindly supplied by Department of Agriculture for Scotland)

	1941	1942	1943	1944	1945	1949	1950
Aberdeen	353	373	398	436	385	177	179
Angus	169	130	208	206	207	99	103
Argyll*	282	267	406	386	360	272	228
Ayr	114	81	171	186	124	53	43
Banff	61	68	84	76	85	55	32
Berwick	65	36	46	33	36	13	5
Bute	22	42	54	62	118	40	67
Caithness*	123	110	120	126	125	50	39
Clackmannan	7	4	9	6	8	—	—
Dumfries	65	79	108	96	73	35	67
Dumbarton	79	71	110	131	90	24	19
East Lothian	40	76	119	118	103	25	11
Fife	172	178	231	215	203	78	46
Inverness*	218	292	359	313	342	257	168
Kincardine	59	51	79	65	56	33	25
Kinross	26	26	33	43	35	13	20
Kirkcudbright	57	52	176	183	192	106	52
Lanark	248	177	281	242	204	65	48
Midlothian	90	46	162	90	78	23	18
Moray	40	43	82	61	78	34	30
Nairn	9	11	26	19	4	1	—
Orkney	29	23	31	34	29	8	25
Peebles	15	15	10	18	16	12	2
Perth	111	125	167	181	159	115	115
Renfrew	51	49	60	59	72	36	37
Ross & Cromarty*	271	206	325	310	328	164	152
Roxburgh	18	15	15	24	43	13	27
Selkirk	5	7	11	10	15	2	1
Stirling	128	121	190	141	147	49	41
Sutherland*	61	40	84	86	99	32	51
West Lothian	89	85	124	118	107	39	45
Wigtown	47	55	53	62	56	29	11
Zetland*	34	59	51	75	86	93	83
Scotland	3,158	3,013	4,383	4,211	4,063	2,045	1,790

1952	1957	1959
1,467	1,696	2,366

* *Crofting counties*

NUMBER OF GOATS ON AGRICULTURAL HOLDINGS AS RETURNED AT JUNE 1942 AND 1943 AND DECEMBER 1946, 1949, AND 1951

COUNTY		MILCH GOATS					OTHER GOATS					TOTAL GOATS				
		1942	1943	1946	1949	1951	1942	1943	1946	1949	1951	1942	1943	1946	1949	1951
Bedford	1	162	197	149	163	112	200	178	78	111	67	362	375	237	274	179
Berks	2	256	258	266	334	268	286	267	195	214	178	542	525	461	548	446
Buckingham	3	247	279	248	386	251	323	287	163	229	161	570	566	411	615	412
Cambridge	4	426	516	372	330	263	417	401	174	198	123	843	917	546	528	386
Isle of Ely	5	313	374	245	144	104	514	250	119	58	34	627	624	364	202	138
Chester	6	308	340	261	233	177	378	423	183	156	171	686	763	444	379	348
Cornwall	7	556	408	273	492	504	335	580	268	371	283	891	988	541	863	787
Cumberland	8	281	306	240	192	168	234	276	140	133	88	515	582	380	325	236
Derby	9	397	360	359	405	280	549	463	263	262	229	946	843	622	667	509
Devon	10	506	598	661	826	674	790	816	490	551	434	1,296	1,414	1,151	1,377	1,108
Dorset	11	391	358	295	512	327	438	406	233	271	241	829	764	516	583	568
Durham . . .	12	987	1,044	701	534	420	825	803	379	273	237	1,812	1,847	1,080	807	657
Essex	13	1,620	1,685	1,458	1,384	1,102	1,583	1,506	725	784	543	3,203	3,191	2,183	2,168	1,645
Gloucester	14	515	557	406	555	306	625	559	235	270	183	1,140	1,116	641	625	489
Hampshire	15	831	946	769	977	662	1,045	977	432	678	370	1,876	1,923	1,201	1,655	1,032
Isle of Wight	16	47	55	23	19	25	77	68	21	26	18	124	121	44	45	43
Hereford	17	183	235	147	187	117	229	246	108	127	68	412	469	255	314	185
Hertford	18	417	420	337	430	311	523	457	196	230	157	940	877	533	660	468
Huntingdon	19	183	203	140	99	78	233	160	66	64	45	406	363	206	163	123
Kent	20	881	815	731	901	621	936	914	389	652	374	1,817	1,729	1,120	1,553	995
Lancaster	21	1,377	1,308	988	936	771	1,513	1,241	603	643	513	2,890	2,549	1,591	1,579	1,284
Leicester	22	209	151	172	134	157	187	189	105	119	104	396	540	277	253	261
Lincoln (Holland)	23	109	112	81	65	73	123	90	57	60	45	232	202	138	123	118
,, (Kesteven)	24	152	104	99	113	77	175	147	70	81	59	327	251	169	194	136
,, (Lindsey)	25	364	396	307	323	233	507	550	237	177	155	871	946	544	500	388
Middlesex	27	66	83	49	56	24	133	134	33	68	20	199	217	82	124	44
Norfolk	28	1,323	1,505	1,095	1,105	832	1,493	1,364	463	668	435	2,816	2,869	1,558	1,773	1,267
Northampton..	29	246	203	172	294	138	276	236	90	145	80	522	439	262	439	218
Soke of Peterborough ..	30	55	66	56	27	53	47	38	19	18	6	102	104	75	45	59
Northumberland	31	309	311	235	228	175	291	307	160	139	109	600	618	395	367	284
Nottingham	32	267	305	239	314	227	313	328	169	205	164	580	633	408	519	391

Appendix 3

THE IMPORTANCE OF 'WEEDS' IN GOAT NUTRITION

CONSTITUENTS OF THE DRY MATTER OF VARIOUS PASTURE PLANTS

(after Prof. F. W. Fagan, Brynmor Thomas and C. B. Fairbairn)

Plant	*Crude Protein* %	*Fibre* %	*Calcium* *(CaO)* %	*Phosphorus* *(P_2O_5)* %	*Sodium* *(Na_2O)* %	*Chlorine* *(Cl)* %	*Magnesia* *(MgO)* %	*Cobalt* *(p.p.m)* %
Bilberry	15·70	16·07	0·75	0 77		0·14		
Burnet			1·84	0 62	0·07	0·15	1·82	0·18
Buttercup	25·06	16·76	1·48	1·44	0 89	0·25	0·34	0·25
Catsear	19·55	20 06	1·45	0 81		3·47		
Chickory	19·20	13 40	2 00	1·11	0·37	0 92	1·07	0·20
Cowslip	12·64	15·81	1·55	0·54		0 53		
Daisy (Stem)	14·30	18 66	1·24	1·17		1·10		
Dandelion	19·36	11·27	1·80	0 98	0 86	2 00	0·78	
Devil's Bit	12 86	21·42	1·23	0 63		0 50		
Gorse	16 84	33·10	0·71	0 74		0·53		
Hawkbit	18 62	18 82	2 38	0 90		1·88		
Heather (Calluna)	8·56	21·67	0 47	0·22		0 07		
Heath Rush	14·03	23 92	0·18	0 50		0·46		
Hogweed	20·07	15·50	1·72	1·01		0·82		
Knapweed	20 16	19·02	1·56	1 08		0·20		
Lady's Bedstraw	16 49	22·14	0 49	0 57		0·32		
Nettles	27·45	32 67	5·99	1·75		1 01		
Ox-Eye Daisy	10 80	27·88	1·06	0·74		0·53		
Plantain (Broad leaved)	18 61		3·39					
Plantain (Ribgrass)	20·25	14 84	2·32	0·75	0 62	0 40	1·01	0·20
Self Heal	10 32	18·57	1·20	0 61		0·67		
Sorrel	24·71	15 38	0·71	1·37	0 27	1·25	0·26	0·22
Shepherd's Purse	27·26	26 65	2 85	1·35				
Sowthistle	17·76	20 83	2·10	1·12		1·70		
Speedwell	12·20	22·90	1·35	0 86		0·28		
Tormentil	10·50	27·36	1·07	1 03		0·21		
Creeping Thistle	29 64		2·97	1·17				
Thistle (Melancholy)	17·50	14·56	4 61	0·94				
Yarrow	19 90	24·31	1·57	0 69	0 06	0·53	0·75	0·17
Yellow Rattle	23·10	20 60	1·88	2·12	0·21	1·40	0 73	

CONSTITUENTS OF THE DRY MATTER OF VARIOUS PASTURE PLANTS—*continued*

Plant	*Crude Protein* %	*Fibre* %	*Calcium (CaO)* %	*Phosphorus* (P_2O_5) %	*Sodium* (Na_2O) %	*Chlorine (Cl)* %	*Magnesia (MgO)* %	*Cobalt (p.p.m)* %
Average of above	16·70	20·49	1·66	0·91	0·27	0·87	0·85	0·20
Legumes:								
Trefoil	17·5	28·5	2·32	0·79	0·18	0·56	1·27	0·20
Alsike	22·0	30·0	2·79	0·76	0·06	0·42	1·04	0·17
Lucerne	17·0	30·0	3·01	0·91	0·10	0·50	0·91	0·15
Sainfoin	17·5	34·5	1·44	0·89	0·06	0·14	1·31	0·16
Clover (Wild White)	23·31	23·09	3·08	0·89				
Average	*19·2*	*29·1*	*2·53*	*0·85*	*0·10*	0·41	*1·13*	*0·17*
Grasses:								
Crested Dogstail			0·46	0·53	0·11	0·56	0·44	0·18
Yorkshire Fog			0·32	0·71	0·18	0·80	0·19	0·17
Peren. Ryegrass	12·2	26·0	0·65	0·59	0·19	0·51	0·35	0·15
Cocksfoot			0·59	0·59	0·17	0·31	0·36	0·14
Timothy			0·58	0·53	0·30	0·56	0·42	0·15
Meadow Fescue			0 62	0·58	0·20	0·66	0·44	0·16
Average			0·54	0·59	0·19	0·57	0·37	0·16

Note. The mineral reason why grass is an unsatisfactory food for goats, especially for young stock and milkers, is most striking. The relative poverty of the legumes in sodium and chlorine is a particularly serious matter for the goat, who excretes 50 per cent more of these elements in each gallon of milk than does the cow.

Manganese is an element of special importance for male fertility. Only very recent analyses are reliable. Meadowsweet and willow herb are relatively rich in it.

The above table includes some unpublished data from Brynmor Thomas and C. B. Fairbairn of Durham University School of Agriculture.

Appendix 4

GOATS' MILK PER ACRE

It is an historical fact that the goat population usually increases when war or adversity force a people to make the utmost use of the land they live in. Here is one of the reasons:

The amount of animal feeding produced by one acre of average British dairy farmland will sustain completely the following stock and production:

	Type of Stock	*Yield per Head per annum gallons*	*Stock per Acre*	*Yield per Acre gallons*
	Cow (average)	600	0·5	300
or	Goats	150	2·25	338
or	Goats	200	1·96	392
or	Goats	250	1·62	405
or	Goat (Champion)	450	0·96	432

Appendix 5

SOME WEIGHTS AND MEASURES OF THE MAIN GOAT-KEEPING COUNTRIES, WITH THE BRITISH EQUIVALENTS

Metric System

1 Decimetre	=3·94 inches	1 Litre	=1·76 pints 0·22 gallons
1 Metre	=3·28 feet		
1 Sq. metre	=10·764 sq. feet	100 Grams	=3·53 oz.
1 Hectare	=2·47 acres	1 Kilo	=2·2 lb.
		1 Quintal	=1·9684 cwt.

China

1 Li	=2·115 feet	1 Kin	=1·33 lb.
1 Mow	=0·166 acre	1 Picul	=133 lb.

Egypt

1 Kassabah	=11·64 feet	1 Kela	=3·63 gallons 29·04 pints
1 Feddan	=1·038 acres	1 Rotl	=1 lb.
		1 Cantar	=100 lb.

India

		1 Seer	=1·76 pints
1 Danda	=6 feet	1 Dangali	=3 pints
1 Bigha:		1 Parah	=15 gallons
(Bengal)	=0·33 acre	1 Seer	=2·06 lb.
(Bombay)	=0·8 acre	1 Maund	
(Madras)	=1·33 acres	(Bengal)	=82·28 lb.
		(Bombay)	=27·86 lb.
		(Madras)	=24·68 lb.

Japan

1 Shaku	=1 foot	1 To	=3·97 gallons
1 Kwan	=8·26 lb.		31·76 pints

Turkey

1 Endaze	=25·55 inches	1 Almud	=1·15 gallons
	2·129 feet	1 Oke	=2·832 lb.
1 Djerib	=2·47 acres	1 Cantar	=124·36 lb.

Appendix 6

SUPPLIERS OF THE REQUISITES FOR GOAT-KEEPING

All small equipment, milking-pails, hay-racks, tethers, collars, etc.:
The Emston Saddlery Company, Newgate Street, near Hertford.

Veterinary herbs, garlic, tree-bark blend, etc.:
Organic Herbal Products Ltd., 40 St. Mary Street, Bridgwater, Somerset.

Special seeds and seed mixtures for goat crops:
Hunters of Chester, Chester; and Organic Herbal Products Ltd., Bridgwater, Somerset.

Goats: Contact local Goat Club Secretaries for stock available in the district and the current number of the *British Goat Society Year Book* for a list of pedigree breeders with stock for sale. The *Monthly Journal of the British Goat Society* includes 'Stock for Sale' advertisements.

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